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ABSTRACT

The vision of the National Institute for Science Education (NISE) is that all students should leave the educational system with an ability to make informed decisions about the science, mathematics, engineering, and technology (SMET)-related matters that they encounter in their daily lives. This report documents the accomplishments and activities of NISE. The first section is an overview of the vision, goals, strategies, and organization of NISE. The section on Research Programs describes the research in three areas of SMET education: (1) evaluation and policy studies, (2) professional development, and (3) college level one. The next section highlights the work of NISE in interacting with professional audiences and communicating with mass audiences. The section on Organizational Process Programs describes initiatives that enhance the overall efficiency and productivity. In its first year NISE has initiated eight productive lines of research, recruited a diverse group of Fellows, and made great strides in creating interdisciplinary teams of researchers. The Institute has also established productive collaborative relationships with the Education and Human Resources Directorate programs of the National Science Foundation, implemented and modified the management structure, and initiated collaborative work with a wide variety of professional organizations. Included is a list of NISE staff and Fellows. Contains 26 references. (JRH)

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National Institute for Science Education

University of Wisconsin–Madison • National Center for Improving Science Education

September 20, 1996

ED 405 198

NISE OVERVIEW

Year 1 Accomplishments and Year 2 Activities

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Executive Summary

The NISE's *vision* is that all students leave the educational system with an ability to make informed decisions about the matters related to science, mathematics, engineering, and technology (SMET) that they encounter in their daily lives. In this vision, all stakeholders in SMET education engage in active, contextual learning to acquire both a strong foundation in SMET and the ability to enhance that foundation as lifelong learners. The NISE, funded by the Education Human Resources Directorate (EHR) of the National Science Foundation, began work in July 1995.

The NISE comprises students, staff, and faculty from the SMET and education colleges at the University of Wisconsin–Madison (UW) and the staff of the National Center for Improving Science Education (NCISE) in Washington, DC. The NISE also includes visiting Fellows representing the various stakeholder groups who are leaders in SMET education nationally and internationally. The UW and NCISE partnership includes a group of participants who, while educated in a wide variety of disciplines, share a common vision and goals for the NISE. It is exactly this multidisciplinary approach that has been absent from most education reform efforts to date. Having completed its first year of work, the NISE is off to a fast start.

First year work was featured at NISE's 1996 Annual Forum in Washington, DC, developed by the Interacting with Professional Audiences team. Its cosponsors included National Science Teachers Association (NSTA), National Council of Teachers of Mathematics (NCTM), Delta Education, Duracell, Merck, and Toyota. The focus of the Forum was Professional Development. Billed as an opportunity for diverse stakeholders to interact in significant ways, the Forum was well received by the community and was fully subscribed. Of the approximately 240 people attending, more than 70% were from "outside the beltway" and represented K–12, higher education, industry, and professional societies.

The Communicating with Mass Audiences team has developed The Why Files, a Web site that explains the science behind the news. The Why Files uses recent headlines as a starting point for detailed descriptions of science, mathematics, engineering and technology issues. This effort allows us to explore and study the potential uses of cyberspace in enhancing both classroom teaching and SMET literacy for all. The site has received much attention. Since its inception in February 1996, the Why Files has earned virtually every major Web award and citation, including being named Microsoft "site of the day" twice. The Why Files hit a major milestone the last week of July 1996—downloading the millionth file. In addition, the Web site has been visited by people from 70 countries. The Why Files were created so that NISE could study the use of the Internet to promote scientific learning.

Part of the mission of the NISE is to provide a national leadership role in enhancing the quality of SMET education. This goal is being accomplished through a variety of mechanisms (e.g., scholarly publications, formal and informal presentations, materials on the Internet and the Web, and collaborative efforts). The NISE has collaborated with a number of other SMET organizations to provide leadership in SMET education. For example, we sponsored and arranged the kickoff meeting of Project EXTEND. The goal of this project, funded by the Exxon Education Foundation, is to extend the dialogue on the NCTM Standards. In addition, the NISE Evaluation and Policy Studies teams are collaborating with the Council of Chief State School Officers (CCSSO). The CCSSO is analyzing state policies and practices in mathematics and science and, in collaboration with the NISE, has held a conference on alignment and produced a paper on criteria for judging alignment of Standards/Frameworks and Assessment. We also are initiating collaborations with the informal science community through the Milwaukee Public Museum, a national leader in informal SMET education. We played a key role in the follow-up activities

associated with the EHR February 1996 meeting on The Social Sciences Contribution to the EHR Undergraduate Review.

There is a new and exciting opportunity to enhance the NISE's leadership role nationally. In January 1996, the Wisconsin Center for Education Research, home site for the NISE, was awarded the OERI National Research and Development Center on Achievement in School Mathematics and Science. The work of the OERI Center was designed to complement the NISE; it is directed by Thomas Romberg, a member of the NISE Management Team. The focus of the new center is on research and evaluation of classroom practice in K–12 SMET education. We are excited about the possibilities for synergism between the new Center and the NISE.

Organizational Structure

The NISE is structured to be a highly interactive collegial system, while maintaining the clear lines of authority and responsibility necessary to ensure quality, accountability, direction, and leadership. The NISE actively fosters collaborative work and full cooperation among the education and science faculties at the University of Wisconsin–Madison and throughout the nation. The multidisciplinary nature of the NISE's work is reflected in parity between scientists and educators throughout the management structure and in the composition of project teams.

A 10-person Management Team consisting of a balance of scientists, education researchers, education practitioners, and representatives of the industrial sector meets quarterly to provide advice on the quality and direction of NISE work.

An 18-person National Advisory Board consists of a rich and balanced mix of scientists, education researchers, education practitioners, and representatives from business, industry, government, and foundations. The Board provides advice and direction to NISE's work and enhances its visibility and impact.

Fellows are recruited to the NISE and are an integral part of the NISE project teams. Represented among the Fellows are all levels of colleagues, including K-12 teachers and professors and researchers from the postdoctoral level to the most senior ranks. This breadth and diversity enhances the quality of the discourse and maximizes the impact of the work of the Institute. There is no explicit requirement on length of stay at the NISE, but Fellows are generally in residence for periods of time sufficient to allow meaningful interaction with NISE faculty and staff.

Research Programs

The NISE is pursuing research in three areas of SMET education: Evaluation and Policy Studies, Professional Development, and College Level One.

In the Evaluation and Policy Studies area are two teams. The goal of the **Policy Analysis of Systemic Reform** team is to understand how systemic reform in mathematics and science is being implemented and with what effects. In our work on systemic reform, we seek to know the nature of the evolving content and assessment standards; the politics surrounding development and implementation of standards at the national, state, local, school, and classroom levels; the nature of the implementation process for restructuring within district and school; the degree to which classroom practice has changed toward that envisioned in the standards; and impacts on student learning, disaggregated by basic and advanced skills as well as by race and income. We particularly want to imbed the emerging information on the NSF Systemic Initiatives within this broader context. The work is designed to address the information needs of EHR with its emphasis on systemic reform in mathematics and science.

The **Strategies for Evaluating Systemic Reform** team is well aware that systemic evaluation is an emerging field. Nobody knows how to evaluate systemic initiatives to determine their full impact or how information can best be used to advance such initiatives. The complexity of educational

systems, the difficulty in mounting coherent movement toward unifying goals, the number and range of influential forces, the fluctuation in the political and economic climates, the resources needed to sustain movement over time, and the lack of uniformity of progress within a large system all contribute to the problem of determining the value and worth of these initiatives. Lack of knowledge about systemic evaluation is the central problem being addressed by the Strategies for Evaluating Systemic Reform project. The main goals of the project are to produce knowledge about systemic evaluation and determine how to do systemic evaluation.

Professional Development is essential to effective educational reform. The EHR goal that every child in the United States has access to high-quality school education in science and mathematics cannot be realized without the availability of effective professional development for teachers. The intent of this project is to capture the learnings of current professional development efforts that will increase the knowledge base from both "craft wisdom" and disciplined inquiry and make that information accessible to practitioners and researchers alike.

The project has three goals. The first is developing a framework for the design of professional learning opportunities for K-12 inservice science and mathematics teachers in order to expand the range of alternatives available to professional developers beyond the traditional format of workshops and institutes. The second goal of the project is to create a professional dialogue for elaborating and understanding the design framework and the issues raised in implementing, sustaining, and scaling up professional development learning opportunities. The third goal of the project is to create products that provide guidance to designers, funders, consumers, and evaluators of professional development.

The **College Level One** (CL-1) team recognizes that high quality undergraduate programs in science, mathematics, engineering, and technology have a substantial impact on providing general SMET literacy for all students, preparing students for careers in SMET fields and in teaching, and in addressing equity issues. Experiences in first-year courses greatly influence career trajectories and lifelong attitudes toward SMET-related fields. The objective of the College Level One (CL-1) Team is to identify and study critical issues related to these courses. The team is addressing such issues as how first-year college courses in SMET can be made more attractive to students, add value for those who take them, and enhance the likelihood of success across the wide spectrum of students who enroll in them.

Dissemination Programs

The NISE is committed to disseminating its work to a wide range of audiences.

The overarching goal of the **Interacting with Professional Audiences** team is to ensure that the new knowledge generated by the Institute gets into the hands of all professionals who can make use of it. The team helps Institute researchers identify and connect with relevant audiences beyond the academic community and develop effective means of reaching them. As a result, a much broader range of professionals and their organizations will be knowledgeable enough to make use of Institute endeavors than is often the case for university-based research projects. The three primary goals of the Interacting with Professional Audiences team are (1) to share knowledge and information generated by NISE with key SMET stakeholders, (2) to promote interaction and dialogue among SMET stakeholders about NISE research directions and applications, and (3) to encourage policymakers and practitioners to put research knowledge about SMET education into action.

The **Communicating with Mass Audiences** team reached its first major milestone: developing and disseminating to the public a Web site that promotes SMET literacy by creating information packages pegged to mass media headlines. The Why Files (the name is a play on the hit television program "The X-Files") combines skillfully written text, compelling graphics, timely news photos, and strategic linkages to other Web sites to produce a powerful communication tool to mass audiences.

In Year 2, the team is developing a research effort. In Phase One, the research team is gathering de-

scriptive data on Web communication patterns, using The Why Files audience members as prospective study subjects. In Phase Two, using the initial information gathered, the team will delve more deeply into questions about the effectiveness of communication via the Web. As a result of our inquiry, we hope to be able to suggest specific strategies for improving Web communication. These strategies will then be tested by our Why Files developers and studied again, using standard research and development processes.

In addition, the Communicating with Mass Audiences team will increase awareness of the NISE by publicizing newsworthy deliverables, positioning NISE personnel as SMET education experts, and aggressively marketing The Why Files to increase its reach.

Organizational Process Programs

To enhance the overall efficiency and productivity of its work the NISE has two initiatives.

The goal of the **Cognitive Studies of Interdisciplinary Communication** team is to understand interdisciplinary collaboration and improve such collaboration within the NISE. We are reviewing research and conducting observational studies of NISE teams that will help us describe, understand, and ultimately design and implement new ways to facilitate the communicative processes that influence productivity and quality of work in interdisciplinary teams. We hypothesize that good collaborative teams will evolve toward a state of "collective intelligence," which entails functioning more like a coherent, intelligent organism than like a collection of disassociated, independent thinkers. We hypothesize that collective intelligence is a type of group behavior that might be promoted and enhanced through design and use of technologies that facilitate idea processing during and between team meetings.

The **NISE Formative Evaluation** team provides diverse forms of evaluation support for the Institute. The Formative Evaluation team's primary role is to provide internal "formative feedback" information to improve the Institute's functioning as an agile and productive organization capable of achieving its stated and emerging goals. Secondary roles played by the Formative Evaluation team are to produce an evolving history of the organization; provide, gather, and manage information on organizational activity; and engage in collaborative work with various NISE teams.

Summary

In the first year of the NISE, we have:

- initiated eight productive lines of research;
- recruited a diverse group of Fellows to collaborate with us in pursuit of our mission;
- made great strides in creating high quality interdisciplinary teams of researchers who work together effectively;
- established increasingly productive collaborative relationships with EHR's programs;
- implemented and modified, where appropriate, our proposed management structure, including the creation of a highly visible National Advisory Board that will meet in Fall 1996; and
- initiated collaborative work with a wide variety of professional organizations in SMET education.

Our emphasis on dissemination is paying off with, for example, a fully subscribed first-year NISE Annual Forum and The Why Files on the Web being accessed by literally thousands daily. The EHR's establishment of the NISE has created an enormous excitement across the SMET community. We have received hundreds of statements of interest, requests for information, and visitors to the Institute. Our mission is ambitious, but our commitment is great. At the end of five years, we expect to have launched a whole new approach for the continuous improvement of SMET education. The goal of high levels of SMET literacy for all segments of our population will have become better understood and more broadly accepted. New communities of scholarship and practice will have been established, where scientists, education researchers, and education practitioners work collaboratively to attack the enduring problems of SMET education, problems that have resisted solutions from more narrow approaches.

Overview

Institute Vision, Goals, and Strategies

Institute Vision

The National Institute for Science Education (NISE) is confronting head-on the challenges facing our education system from kindergarten through graduate school. The NISE works with the Education and Human Resources Directorate (EHR) of the National Science Foundation (NSF) to transform the way science, mathematics, engineering, and technology (SMET) are taught. The complexity of this system with its multiple stakeholders requires our responsive, collaborative, and coordinated approach.

The NISE's *vision* is that all students leave the educational system with an ability to make informed decisions about the SMET-related matters that they encounter in their daily lives. In this vision, all stakeholders in SMET education engage in active, contextual learning to acquire both a strong foundation in SMET and the ability to enhance that foundation as lifelong learners. There are three broad principles that form the basis for active, contextual learning and that guide our vision for the NISE:

1. Science is a way of knowing and learning and not merely a body of already established facts. All students, not just academically elite or science track students, should understand how knowledge is generated as well as be knowledgeable about already established results.
2. Students and teachers should be regarded as active participants in the construction of knowledge they "own," rather than as passive recipients of knowledge that belongs to external authorities.
3. The development of shared understanding is a complex, recursive process requiring continuous cooperation and collaboration among different participants.

While the American education system has delivered an outstanding preparation for lifelong learning to a select group of students—primarily to some students from the middle and upper classes—most majority students and virtually all students from underrepresented groups have been inadequately prepared in the SMET areas. Our society cannot afford to waste this intellectual potential. We are working to ensure that all Americans receive the best possible education, especially in SMET.

The NISE comprises students, staff, and faculty from the SMET and education colleges at the University of Wisconsin–Madison (UW) and the staff of the National Center for Improving Science Education (NCISE) in Washington, DC. The NISE also includes visiting Fellows representing the various stakeholder groups who are leaders in SMET education nationally and internationally. The UW and NCISE partnership includes a group of participants who, while educated in a wide variety of disciplines, share a common vision and goals for the NISE. It is exactly this multidisciplinary approach that has been absent from most education reform efforts to date. The overwhelming challenges facing SMET education cannot be effectively addressed by homogeneous teams consisting of either education researchers or SMET researchers working independently. These communities have for too long operated on parallel paths with little interaction, to the detriment of SMET education.

Institute Goals

The NISE shares the larger goals of universal SMET literacy with the National Science Foundation (NSF) and the SMET community (NSF, 1993).

- Educate lifelong learners who are science and technology literate and workforce contributors.
- Ensure access and opportunity for all from kindergarten to graduate school (K–GS).
- Encourage a nationwide community of SMET and education researchers and practitioners to work collaboratively to continually strengthen SMET education.

- Work toward developing a seamless web of integrated experiences and expectations from kindergarten through college that prizes local adaptation, experimentation, and evaluation.

The NISE's primary work focuses on the more specific goals:

- Enhance the knowledge base through improved indicators, student assessment, and program evaluation to support increased efficiency and effectiveness in learning.
- Facilitate sharing of information about exemplary programs and practices.
- Conduct policy analysis at all levels of the education hierarchy to strengthen the policy environment for SMET education.
- Work collaboratively with the NSF Education and Human Resources (EHR) Directorate to ensure maximum effectiveness of its programs and practices.
- Provide demonstration sites for systemic reform in action.

Institute Strategies

We recognize that our broad vision cannot be fully achieved within a fixed time frame and a limited budget. However, we seek to make major advances by using the following strategies:

1. Operating through a partnership involving a university that provides nationally recognized researchers and reformers from its SMET colleges and its School of Education; a Washington, DC, site that facilitates communication with NSF and allows us to host conferences that are easily accessible to key federal policymakers; and the NSF's EHR Directorate.
2. Fielding a team of PIs, having parity between SMET researchers and education researchers, to ensure that the maximum experience, understanding, and wisdom are brought to bear on complex problems.
3. Actively involving K–12 teacher collaborators in our work.
4. Bringing visiting Fellows to both sites who represent the best in the SMET education field nationally and internationally.
5. Collaborating with business and industry. As employers of most of our graduates, exemplars of work-place education, and providers of student practicum sites, they are key stakeholders in SMET education.
6. Focusing on key points of leverage in the K–GS system.
7. Providing national leadership by forming alliances with key organizations and individuals across the country, including scientific, engineering, and professional societies, education research societies, K-12 teacher organizations, leaders of equity action groups, accreditation agencies, and local, state, and federal government officials and agencies.
8. Utilizing demonstration sites for testing and evaluating NISE processes and products.
9. Forming network alliances.

We are forming network alliances to work on selected problems facing SMET education reform. Since reform is so complex, it requires active participation of representatives of all stakeholders in NISE projects. To achieve successful educational reform, communication among NISE staff and stakeholders must shift from unidirectional knowledge transmission (where experts tell teachers how to do it) to multidirectional interactions involving knowledge sharing and negotiation (where network alliances will involve multidisciplinary collaborations among members of the NISE, selected NISE partner project leaders, and relevant stakeholders—all of whom focus on a particular problem). Network alliance members communicate with each other through site visits, intensive conferences, and technological media (e.g., video- or teleconferencing, the Internet). The intended outcomes of the network alliances are the syntheses of core principles that underlie successful reform in the NISE's focus areas and, ultimately, the desired cultural change in SMET education.

Highlights of NISE Work to Date

Having completed its first year of work in July of 1996, the NISE is off to a fast start. Details of accomplishments and plans are described below, but some highlights are mentioned here. For example, four teams have held national workshops to ensure that their efforts are informed by the larger community (College Level One, National Policy Studies of Systemic Reform, Professional Development, and Strategies for Evaluating Systemic Reform). A number of the teams have prepared scholarly synthesis articles on key topics, with some of these papers authored by NISE Fellows.

The Year 1 work was featured at the 1996 Annual Forum in Washington, DC, sponsored by the NISE. Its cosponsors included National Science Teachers Association (NSTA), National Council of Teachers of Mathematics (NCTM), Duracell, Merck, and Toyota. The focus of the Forum was Professional Development. Billed as an opportunity for diverse stakeholders to interact in significant ways, the Forum was well received by the community and was fully subscribed. Of the approximately 240 people attending, more than 70% were from "outside the beltway" and represented K–12, higher education, industry, and professional societies. Active recruitment and inclusion of diverse constituencies exemplifies the commitment to community building that is being pursued by all NISE teams.

The Communicating with Mass Audiences team has developed The Why Files, a Web site that explains the science behind the news. The Why Files uses recent headlines as a starting point for detailed descriptions of science, mathematics, engineering and technology issues. This effort allows us to explore and study the potential uses of cyberspace in enhancing both classroom teaching and SMET literacy for all. The site has received much attention. Since its inception in February 1996, the Why Files has earned virtually every major Web award and citation, including being named Microsoft "site of the day" twice, most recently by Microsoft United Kingdom in July 1996; Microsoft Network's "Pick of the Day," Netscape's "What's Cool" as recently as July 19, 1996, and rated a Four Star sight—the highest rating—by Magellan, and Magellan and Yahoo's Picks of the Week. The Why Files received the Eisenhower National Clearinghouse Digital Dozen, the Too Cool Award, and the Blue Planet Award. The Why Files has also been cited in *New Scientist: Planet Science*, and reviewed by *Hot Wired* and CNN Computer Connection (June 1, 1996). The Why Files hit a major milestone the last week of July 1996—we downloaded our millionth file. In addition, the Web site has been visited by people from 70 countries, and as many as 100,000 files per day are being downloaded by users. The Why Files were created so that NISE could study the use of the Internet to promote scientific learning.

Part of the mission of the NISE is to provide a national leadership role in enhancing the quality of SMET education. This goal is being accomplished through a variety of mechanisms (e.g., scholarly publications, formal and informal presentations, materials on the Internet and the Web, and collaborative efforts). The NISE has collaborated with a number of other SMET organizations to provide leadership in SMET education. For example, we sponsored and arranged the kickoff meeting of Project EXTEND. The goal of this project, funded by the Exxon Education Foundation, is to extend the dialogue on the NCTM Standards. In addition, the NISE Evaluation and Policy Studies teams are collaborating with the Council of Chief State School Officers (CCSSO). The CCSSO is analyzing state policies and practices in mathematics and science and, in collaboration with the NISE, has held a conference on alignment and produced a paper on criteria for judging alignment of Standards/Frameworks and Assessment. We also are initiating collaborations with the informal science community through the Milwaukee Public Museum, a national leader in informal SMET education. We played a key role in the follow-up activities associated with the EHR February 1996 meeting on The Social Sciences Contribution to the EHR Undergraduate Review. The NISE also coordinates the EHR Special Emphasis Panel on Evaluation as described in the Evaluation and Policy Studies section below.

There is a new and exciting opportunity to enhance the NISE's leadership role nationally. In January

1996, the Wisconsin Center for Education Research (WCER), home site for the NISE, was awarded the National Research and Development Center on Achievement in School Mathematics and Science by the U.S. Department of Education's Office of Educational Research and Improvement (OERI). The work of the OERI Center was designed to complement the NISE; it is directed by Thomas Romberg, a member of the NISE Management Team. The focus of the new center is on research and evaluation of classroom practice in K–12 SMET education. We are excited about the possibilities for synergism between the new Center and the NISE.

Organization and Management Structure

The NISE is structured to be a highly interactive collegial system, while maintaining the clear lines of authority and responsibility necessary to ensure quality, accountability, direction, and leadership (see Figure 1). The NISE actively fosters collaborative work and full cooperation among the education and science faculties at the University of Wisconsin–Madison and throughout the nation. Accordingly, one director of the NISE is a SMET researcher and the other an education researcher. The multidisciplinary nature of the NISE's work is reflected in parity between scientists and educators throughout the management structure and in the composition of project teams.

Building organizational procedures is essential for any new national research institute. In the case of the NISE, however, the development of a functioning institute is something worth documenting and studying as well. NISE's multidisciplinary approach has long been called for in SMET education but largely absent from education reform efforts to date. Much progress has been made in establishing truly effective multidisciplinary work. A multidisciplinary approach characterizes not only the research teams but the entire organizational structure and decision-making process of the NISE. The development of the NISE as a multidisciplinary organization is being carefully documented through the Formative Evaluation efforts led by Susan Millar and the Cognitive Studies of Interdisciplinary Communication led by Sharon Derry (both are described later). We believe that their findings will facilitate the organization and functioning of other such centers.

As originally proposed, a ten-person Management Team consisting of a balance of scientists, education researchers, education practitioners, and representatives of the industrial sector has been created. Led by the co-directors, the Management Team meets quarterly to provide advice on the quality and direction of NISE work.

The Team Leaders Team is a mechanism bringing the co-directors, the project manager, and the team leaders together on a regular basis to share progress, strengthen communications, and make decisions about the implementation of NISE strategies. The Team Leaders Team has established itself as the chief mechanism for coordinating and integrating the NISE scope of work.

The NISE has established an 18-person National Advisory Board co-chaired by Wisconsin Governor Tommy Thompson (former head of the National Governors' Association and the Education Commission of the States) and John Porter, CEO of the Urban Education Alliance and former Michigan Superintendent of Public Instruction. Like all parts of the NISE, the National Advisory Board consists of a rich and balanced mix of scientists, education researchers, education practitioners, and representatives from business, industry, government, and foundations. The Board is to provide advice and direction to NISE's work and to enhance its visibility and impact.

Fellows are recruited to the NISE and are an integral part of the NISE project teams. A call for applications and nominations for NISE Fellows has been widely circulated through the NISE Web site and through direct mailings. Announcements of the application process have also appeared in key professional journals and magazines.
NISE is recruiting a diverse group of Fellows from a wide variety of stakeholder groups, including K–12 teachers, higher education faculty in SMET

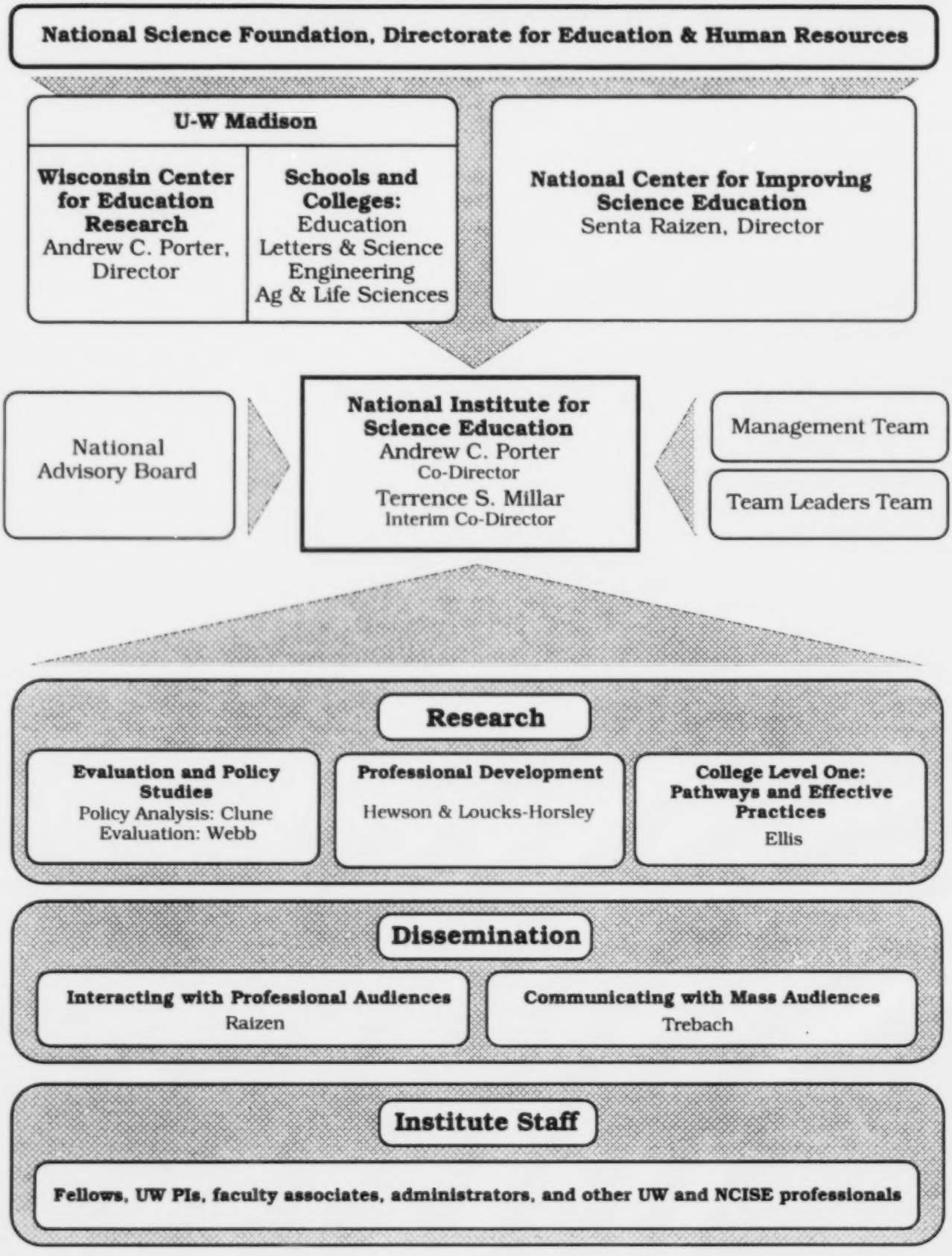

Figure 1. National Institute for Science Education Organization Chart

and education research, industry, private foundations, the media, and government. Represented among the Fellows are all levels of colleagues, including K-12 teachers and professors and researchers from the postdoctoral level to the most senior ranks. This breadth and diversity enhances the quality of the discourse and maximize the impact of the work of the Institute. There is no explicit requirement on length of stay at the NISE, but Fellows are generally in residence for periods of time sufficient to allow meaningful interaction with NISE faculty and staff.

Evaluation and Policy Studies

Policy Analysis of Systemic Reform

The goal of the Policy Analysis team is to generate useful knowledge about implementing systemic or standards-based reform in mathematics and science education. The present moment is critical in the national effort to become "first in the world in mathematics and science." The standards themselves have taken the vital first step by providing a detailed vision of a vastly improved system, complete with benchmarks of achievement at each age level, and have attracted a high degree of consensus and support among a broad group of scientists and educators.

But the next stage of implementation is very challenging. While the standards provide guidelines, they do not explain the sequence of courses and instruction that will satisfy these standards. State and local policymakers and professional groups must "reinvent" the standards in actual practice, in most cases without the same rich level of expertise that was available in developing the standards.

Year 1 Accomplishments

With limited resources and an enormous amount to learn, the challenge for the Policy Analysis team is to carve out an efficient research agenda. Year 1 of the project was spent casting a broad net, appraising the state of our knowledge about reform, and understanding the obstacles. Michael Knapp wrote a paper on the implementation of systemic reform; Michael Kirst on the politics of standards; and several authors (policy analysts, mathematicians and scientists) wrote papers on the national standards themselves. William Clune attended meetings of the systemic initiatives in Washington, DC; and Allan Odden, the original systemic reform leader, was appointed by Governor Tommy Thompson to a newly created Wisconsin Education Task Force on standards-based reform in Wisconsin. Governor Thompson is immediate past chair of both the National Governors' Association and the Education Commission of the States and led a Summit of governors and business leaders on standards-based reform in March 1996.

The research conducted in Year 1 culminated in a "summer seminar" held July 24-25 in Madison, attended by a broad group of reformers, policy analysts, evaluators, and experts in the standards and their subject matters. William Clune wrote a paper synthesizing the problems identified as central in the seminar and suggesting how the future research agenda could be shaped to deliver the most useful knowledge about reform. Clune's paper deals with two general issues summarized below: (1) how to think about systemic reform as an effort to produce substantial gains in student achievement; (2) how to design the research in Year 2 and beyond to produce knowledge that is useful in improving systemic reform in mathematics and science education.

What Is Systemic Reform?

Systemic reform is the creation of deep and broad gains in student achievement through a substantial upgrading of instruction (systemic change), produced through the cumulative and coherent influence of multiple policy instruments (systemic policy). The "deep and broad" aspect of systemic reform can be contrasted with prior reforms that have been either broad and shallow (for example, a high school graduation requirement of three rather than two mathematics courses) as well as "deep and narrow," (for example, tremendous improvement in one or a few schools or among a few teachers).

How Systemic Is Enough (How Deep and How Broad)?

If systemic reform is characterized by depth and breadth of change, a critical question is, How deep and how broad? A working definition of systemic change for any one change effort would be that the achievement of at least 10 percent of

the students in an area improves by at least one performance benchmark on an appropriate test. Systemic reform can then be defined as any set of interventions achieving this result. The 10 percent threshold is suggested as a way to give some teeth to the definition of reform, without requiring immediate universal change, and is guided by the example of the Advanced Placement exams that function to raise the achievement of about 10 percent of the nation's students about one full grade level (that is, from 12th grade to first-year college). Despite some disagreements about content, most people would consider the AP an effective system.

What Kind of Multiple Policy Instruments?

There has been a broadening in our understanding of what combinations or packages of policy instruments are capable of producing broad and deep systemic change. The "traditional model" of policy alignment is still viable (alignment among curriculum guidelines, student assessments, and professional development) and is being implemented in various places, for example, Kentucky, Charlotte-Mecklenberg, and Dallas. A second model in common practice is the "network" of professional development and school restructuring. School improvement networks such as "Success for All" have changed instruction and achievement in many schools, and networks of professional development in California predated policy alignment and survived even when the state testing system collapsed. Less is know about the potential of national (but not governmental) systems of curriculum and testing (such as Advanced Placement) and powerful (widely accepted) curriculum models and textbooks. Obviously it is possible for these systems to reinforce each other, and many "systemic initiatives" do consist of such combinations.

Year 2 Activities

Given this concept of systemic reform, what research projects can deliver the most powerful knowledge about how to bridge the gap between standards and practice? Below is the research agenda that emerged from the review of systemic reform conducted by the Policy Analysis team in Year 1.

The Year 2 research agenda has already been approved by NSF, and the following four research projects will be completed during this year.

1. Centralized and decentralized systemic policies

Research question: Are there decentralized and nongovernmental alternatives to the "classic" vision of systemic policy that are equally capable of producing systemic change?

Policy Problem: The classic version of systemic policy (alignment of official curriculum guidelines, student assessments, professional development, and texts) does not appear to be the only kind of system that produces systemic change (large scale upgrading of instruction and student achievement). Policymakers should be aware of these alternatives, especially because the classic model is not always available or effective, and the alternatives may be less expensive.

Methodology: Commission a major paper on a variety of systems which have demonstrated a capacity for systemic change. Analyze the common features of more or less "complete" systemic policies that have demonstrated some success in various parts of the country, regardless of whether the policies are part of a systemic initiative or are oriented toward the new standards (thus distinguishing the efficacy of instructional guidance from the particular content being advanced). Common features analyzed will include source of "alignment at the bottom" (method of acquiring influence over correspondence of curriculum, tests, texts, and training), plus incentives to participate. Examples could include: (a) the Advanced Placement system, (b) state- and districtwide reform efforts (such as Kentucky and Charlotte-Mecklenberg), (c) successful school improvement and professional development networks that show some evidence of going to scale (e.g., Success for All, Annenberg, New American Schools), and (d) informal links between textbook publishers, teachers, and schools.

This analysis will look not only for the key policy ingredients (such as coherence, organizational capacity, and incentives and evaluation systems) but also what Allan Odden called "management"

—what makes the policies work together toward coherent outcomes. Attention also will be paid to verification of systemic effectiveness (what is the evidence that systemic change has occurred).

2. A "systemic change power rating" of systemic reforms in the systemic initiatives

Research question: Based on knowledge acquired to date, what combinations of policy instruments adopted by the systemic initiatives appear most likely to produce systemic change?

Policy problem: The systemic initiatives are designed to produce change and knowledge about the effectiveness of systemic policy, and some initiatives have been judged more effective than others. But knowledge about effective/ineffective policies has not been systematized and widely shared in a way that can guide policymakers.

Methodology: Commission a major paper that will develop and validate a system for rating the "power" of the NSF systemic initiatives, including the probable impact on teaching and learning, tradeoffs between long and short run change, and breadth vs. depth. This project will refer to the criteria already utilized by NSF in evaluating the promise and success of systemic reform and also on the knowledge and judgment of principal investigators and program officers, as well as the overlapping work of the Evaluation unit within NISE.

3. Adjustments in the systemic initiatives due to local political context

Research question: What kinds of adjustments in the policy interventions of systemic initiatives have been necessary because of different political contexts and cultures?

Policy problem: It is apparent from the summer seminar and other discussions that most, if not all, systemic initiatives put a major effort into adjusting the structure of their policy interventions to the local context. For example, Uri Treisman, the Principal Investigator of the Texas Statewide Systemic Initiative, explained the impact of state decentralization on his project. The problem is that the classical model of systemic policy did not discuss the details of such adaptation, and there has been little systematic knowledge produced about it (although studies of systemic reform do reach some generalizations).

Methodology: Knowledge about the dynamics of systemic initiatives is possessed mainly by those involved with them, and local circumstances are often fluid and dynamic. Consequently, this project can best be handled by a new problem-solving group consisting of staff from NISE, NSF, and the systemic initiatives. Small papers on political strategies and policy adjustments will be issued by the group on the basis of discussions held bimonthly in Washington, DC.

4. Equity interventions that produce systemic change in course work and student achievement

Research question: What educational programs can be identified that, by reputation, have substantially upgraded instruction in mathematics and science and raised student achievement, for a substantial number of poor, minority, and female students?

Policy problem: A substantial amount of data collection and analysis has demonstrated persistent gaps between the achievement of groups in our society, and many programs have been addressed to closing these gaps, but there seems to be little knowledge about the relative success, program content, and generalizability of these programs. Ultimately, knowledge about how to close the gap is more useful than knowledge about the gap itself.

Methodology: Work in Year 2 will be concerned with identifying promising programs, while empirical investigation of the programs can occur in later years. A new working group on equity in student achievement will bring together staff from four centers housed in WCER that are working on similar issues. This group will help identify programs with demonstrated success in producing systemic change in mathematics and science education and share knowledge about the equity issue garnered from different contexts. Perhaps selected staff from Statewide and Urban Systemic Initiatives will be added to this group on an occasional basis for designated topics.

Beyond Year 2 Projects

1. Professional and social consensus/dissensus around the national standards in mathematics and science

Research question: What are the main issues dividing professionals and others about the national standards in mathematics and science, and how much is genuine disagreement as opposed to misunderstanding or exaggeration?

Policy problem: Professional and social disagreements about the standards have begun to hinder the process of reform (for example, the termination of state student assessments in California). However, despite widely publicized disagreements, the summer seminar suggested that there is a high degree of consensus among both educators and science professionals that the mathematics and science standards are correct in continuing much that has always been taught, such as exact calculation and familiar subject matters and topics, as well as an increased emphasis on understanding, scientific thinking, and problem solving. Both traditionalists and innovators are interested in some increased degree of "constructivism" in student learning, at least to the extent that students should understand what calculations and procedures "mean" as well as how to execute them. The relative emphasis on applications in different positions also seems to have been exaggerated. On the other hand, areas of disagreement that do exist are interesting and important and might be useful to policymakers and the public in making decisions. Unfortunately, the national debate has become both ideologically polarized and factually confusing.

Methodology: A scholarly and cogently written paper could explore areas of agreement, dispel mistaken impressions and beliefs, and explain how true and false impressions have become exaggerated and politicized, as well as being honest about the existence of continuing disputes and the manner in which policy has sometimes gone astray. A possible method of comparing different positions would be to assess the similarity of new curricula meeting the standards with different aspects of current curricula and courses.

2. The overlap between new standards and old assessments

Research question: What can policymakers learn from existing assessments about the progress of standards-based reform?

Policy problem: Standardized student assessments, such as NAEP (the National Assessment of Educational Progress), SATs (Scholastic Assessment Tests), the AP (Advanced Placement) tests, are of potentially great significance in the systemic reform movement for three reasons: (1) on content, they translate general content standards into specific learning outcomes; (2) on performance, they spell out the age at which students are expected to acquire the specified knowledge and skill; (3) on progress, they provide a readily available measure of any gains in student learning. This commendable specificity of assessments is exactly why they become sources of disagreement. One disagreement that could benefit from immediate clarification is how much existing measures of student achievement, which do have age-graded benchmarks, overlap with the new national standards. For example, the NAEP, AP, and international tests all make comparisons of groups against performance benchmarks. If a systemic initiative moved 10 percent of students up one benchmark on the NAEP, would that be the kind of progress aimed for by the standards? We know that the standards aim for some qualities not measured by these tests, but is there also an area of overlap? For policymakers who rely on these tests, the existing polarized debate of "good test" and "bad test" must be replaced with "how good in what way."

Methodology: A synthesis paper could be written with two objectives: (a) explain the degree to which existing and widely used measures of student achievement are and are not acceptable indicators of progress in systemic reform (e.g., NAEP, international comparisons, SATs, Iowa and Stanford achievement tests); and (b) explain what additional dimensions will be measured by new assessment systems under development (for example, by the New Standards project), when these might become available, and the implications for teaching and learning.

3. A comparison of ideal standards-based curricula with existing curricula

Research question: How much would the existing mathematics and science curricula of typical schools need to change to match curricula that would be considered ideal (or completely satisfactory) under the standards?

Policy problem: Systemic initiatives and other reform efforts often find themselves in the situation of implementing the standards without specific guidelines. The result often is superficial change or a repackaging of the existing curricula. Many commentators have noted how useful it would be to have a more specific idea of the goals of reform, and a comparison of curricula is one way of illustrating this contrast.

Methodology: The focus of this project should not be on the standards themselves but on a comparison of the standards with existing practice including curriculum, teaching, and assessments. The focus cannot be limited to curriculum in the sense of scope and sequence, because we would also need to understand the demands that new material would place on the classroom practice of the existing teaching force. But, to keep the project from becoming too ambitious at first, a useful starting place might be to assume implementation of some available acceptable curriculum (perhaps in the form of model textbooks), make some assumptions about the learning goals for students at different ages, and ask what extra training, if any, teachers in typical school systems would need to teach in such a curriculum (for example, the possible problem of elementary school teachers teaching higher levels of mathematics at earlier grades).

4. A "Good Housekeeping" system for rating mathematics and science textbooks

Research question: How well do mathematics and science textbooks currently in use measure up to the new national standards?

Policy problem: Textbooks are influential in determining course content, and many existing texts are claiming some degree of conformity to the new national standards. But on close inspection many of the changes made in the textbooks supposedly to meet the standards are superficial and would require little if any change in practice. A rating of texts by an independent group against the standards thus could be a big help in the central task of becoming more specific about reform. There is no system presently in existence for rating textbooks against national standards, although several states do go through an exercise of approving texts against state standards. Since several national organizations have or plan projects for comparing textbooks with the standards, NISE can build on and coordinate with these efforts in analyzing the usefulness of a full blown rating system.

Methodology: A central, authoritative system for rating textbooks would represent a big change in American education. The first step could be a paper that assesses the advantages and disadvantages of such a system, making reference to the textbook studies of national organizations, state approval systems, and the efforts of publishers themselves to meet new standards as they emerge.

5. New ground rules for future systemic initiatives

Research question: Should future versions of centralized policies be designed to encourage systemic reform be modified in light of what we have learned about existing efforts?

Policy problem: The current wave of NSF systemic initiatives was launched in a framework that encouraged a wide variation in approach by states and localities (e.g., desire to encourage experiments and avoid federal control). But the SI program is now well under way, criteria of effectiveness have gradually been developed, data reporting requirements have been changed, and some programs have been judged more meritorious than others. This raises the question of whether future programs should set more stringent conditions of participation, for example, with a better focus on making real changes in student achievement. There are also parallel efforts to stimulate broad scale reform of mathematics and science education, not part of any NSF funded systemic initiative, such as the Governors' summit and the Annenberg projects. Policymakers at all levels could benefit greatly from understanding the accumulated wisdom of these

various efforts about the conditions of greater and lesser success.

Methodology: A paper analyzing the structure of successful reform initiatives could be helpful not only in identifying the components of success but also practical problems such as incentives for states, localities, and schools to participate under stringent conditions and the political problems that might be involved with a stronger central role and potentially fewer grant recipients (at least at first). The paper should not only identify problems but also consider alternative ways of solving them. A broad range of reform initiatives should be examined (NSF's Systemic Initiatives, independent state and local initiatives, Annenberg, etc.).

Staff

The core includes William Clune, team leader; Allan Odden; Andrew Porter; William Tate; Alberto Rodriguez; Ron Jetty; Paula White; Bassam Shakhashiri, and Janice Downer (also on the College Level One NISE team); John Wright, Judy Roitman, Richard Rossmiller, Deborah Tepper Haimo, Senta Raizen, Michael Kirst, and Michael Knapp. We will attempt to schedule meetings to allow Uri Treisman to meet with our team when he visits the campus quarterly.

Strategies for Evaluating Systemic Reform

Systemic evaluation is an emerging field (Chubin, 1995). Nobody knows how to evaluate systemic initiatives to determine their full impact or how best information can be used to advance such initiatives. The complexity of educational systems, the difficulty in mounting coherent movement toward unifying goals, the number and range of influential forces, the fluctuation in the political and economic climates, the resources needed to sustain movement over time, and the lack of uniformity of progress within a large system all contribute to the problem of determining the value and worth of these initiatives. Lack of knowledge about systemic evaluation is the central problem being addressed by the Strategies for Evaluating Systemic Reform project. The main goals of the project are to produce knowledge about systemic evaluation and determine how to do systemic evaluation.

Over the past five years, some progress has been made in learning about systemic reform by those engaged in evaluating the state systemic initiatives (Shields, Corcoran, & Zucker, 1994; Zucker & Shields, 1995; Zucker, Shields, Adelman, & Powell, 1995). Reports of these studies are primarily descriptive information produced using traditional techniques. Most of these techniques and methods come from program evaluation (Scriven, 1993). Little attention has been given to judging how the system has "gone to scale," affecting practices in a significantly large number of classes and resulting in systemic changes in students' learning of science, mathematics, and technology. Absent were methods for detecting large system changes and attributing these changes to the reform initiatives.

This evaluation project is producing thoughtful analyses and studies needed to advance the field of systemic evaluation. The work of the project addresses directly the new challenges that evaluating large educational systems present: large numbers, time frame, colinearity, attribution, achievement gaps, and metrics for measuring systemic progress.

Year 1 Accomplishments

Information about the 24 Statewide Systemic Initiatives (SSIs) was collected and aggregated into two reports.

1. An abbreviated case study of one state's systemic reform activities was written.

2. The evaluators of each existing SSI were asked to send us their most recent evaluation plan. Responses were received from 16 of the 24 states. The information supplied by the evaluators was condensed into a matrix. Each row represents a state. The columns represents the goals of the SSI and the evaluation strategies and techniques used to determine whether the goals are being met. A paper "Purposes and Issues of Systemic Evaluation

in Education" was prepared, drawing on the information received on the evaluations of the SSIs and existing literature. Four purposes for systemic evaluation were apparent from this analysis: design evaluation, management evaluation, leverage evaluation, and verification evaluation. The identified critical issues for systemic evaluation were system-wide impact, time frame, instrumentation, equity, and criteria for judging merit.

An expanding NISE library has been created of documents and reports related to the SSIs and their evaluations. In addition to the collection of reports, a bibliography has been created with over 125 entries of references relevant to systemic reform and its evaluation. Many of the references are in the library. This bibliography will be made available on the Web. An index will be created to make the library more accessible and useful to those engaged in doing evaluations.

A successful two-day conference was conducted on January 4-5, 1996. Twenty-six people from across the nation representing different roles related to SMET met to identify questions for and about evaluation of systemic reform. Questions for an evaluation are those that would be answered by an evaluation. The questions about an evaluation are those that need to be considered in designing an evaluation. Four discussion papers were prepared for the conference. Each paper enumerated a list of questions for and about evaluation centering on a particular area of systemic reform. The conference proceedings are now available.

The arduous task of forming a multidisciplinary network of people interested in the issues related to evaluation of systemic reform was initiated. Those who attended the conference along with another 20 people who could not attend have expressed interest in the work being done. This group of nearly 50 constitutes a beginning network that will be expanded. One function of this group will be to foster greater dissemination of products produced by NISE in general and the Strategies for Evaluating Systemic Reform project in particular.

Year 2 Activities

Two main objectives have been set for Year 2: (1) Continue development of strategies for evaluating systemic education reform: (2) Expand the scholarly attention given by leading evaluation experts from a number of disciplines to help resolve critical problems related to the evaluation of systemic education reform. The project is building on ideas and information produced in Year 1—namely, questions generated for and about evaluations of systemic reform; alignment of standards, frameworks, and assessments; and the state of existing evaluation practices of systemic initiatives.

Conceptualizing Approaches for Evaluating Systemic Reform

Four major areas related to developing models for evaluating systemic reform are being addressed.

Lessons Learned from Statewide Systemic Initiative (SSI) Evaluations. Dr. Charles Bruckerhoff, an evaluator of Connecticut's SSI, is producing a report abstracting lessons learned from the existing evaluations of the SSIs. What is learned will be applied to the evaluation of the Urban Systemic Initiatives (USIs) and the Rural Systemic Initiatives (RSIs). Dr. Bruckerhoff is serving as an NISE Fellow. He is taking into consideration the different contexts for doing evaluations within the SSIs and across the SSIs. The conditions, strategies, and instruments for doing evaluation at the state level are being related to the context, goals, and resources for the USIs and the RSIs.

Methods for Describing Change in Educational Systems. Jim Ridgway, Professor at Lancaster University in the United Kingdom, is writing a monograph building on the assumption that more than one view of change is appropriate in judging the value of systemic initiatives. Research methods and tools from a range of fields relevant to education are being identified. For example, how researchers in epidemiology determine causal relations within large and dynamic systems is being

related to causal analyses of educational systemic initiatives. National mathematics and science curriculum standards are being used as a frame of reference for judging and exploring the application of methodologies from other fields of inquiry to evaluating systemic reform.

Overcoming the Time-Frame Issues in Detecting Systemic Outcomes. Positive evidence of a systemic initiative may not be detectable simply because not enough time has elapsed for teachers to synthesize the change and make adjustments in their classroom practices, for students' activities to have changed, and for student outcomes to be different. Time-frame issues are confounded by the complexity of the instructional process in SMET, the size of the system, and the nature of organized education. Effects of systemic reform over time may not grow linearly, but exponentially or discretely. For example, significant effects that grow exponentially may be less detectable in the early years, but have the potential of eventually expanding to a very large number. Or, effects within a few isolated districts may expand over time to other districts. Systemic evaluations need to be sensitive to different growth models of systemic educational change. Projections, modeling, and other techniques will be explored as possible techniques for attending to time-frame issues. Viable analytic methods will be explored from other fields that have dealt with time-frame issues. For example, epidemiologists use the term "analytic horizon" to identify the time period to be considered with regard to costs and benefits of health outcomes that occur as a result of an intervention (Center for Disease Control and Prevention, 1995). An analogous time period may be useful in considering the impact of educational initiatives.

Equity and Gap Metrics. Jane Butler Kahle, Condit Professor of Science Education at Miami University, is framing the measurement questions associated with determining whether systemic initiatives are making progress toward assuring that schools provide access for all students to high-quality SMET education. Equity is an important cross-cutting theme for measuring progress for educational system reform (Zucker et al., 1995). In the November 1, 1995, draft of the Systemic Reform "Report Card" presented by NSF staff to principal investigators of the systemic initiatives, one of six drivers of systemic change was given as "Reduction in the 'achievement gap' between the students the system serves best and those historically underserved." Differential opportunities and performance are of concern for a range of categories—ethnicity, location, poverty status, gender, and/or the presence of disabilities.

The study of gap metrics is building on the work of the Policy Analysis of Systemic Reform project and its synthesis of changes in the level and nature of student achievement in mathematics and science by gender, race, and socioeconomic status. This work identifies current metrics used to measure the reduction in the achievement gap. Other metrics will be identified and analyzed. For example, a decrease in the difference in achievement between two groups may seem to represent a move toward equity, but in actuality represent a reduction in the overall group performance. The difference in the percentage of two groups achieving a minimum criterion can decrease while the traditionally served students accelerate their learning far above the minimum. The analysis of the achievement gap is complex and requires consideration of multiple metrics.

Expanding the Scholarly Attention Given to Evaluation of Systemic Initiatives

A two-day conference of evaluation experts from education and other fields will be held in February 1997. The four thought papers described above will be the focus for discussion along with other technical issues related to evaluation of systemic initiatives. Proceedings for this conference will be produced.

A University of Wisconsin-based multidisciplinary panel was formed in Year 1 to broaden the perspective given to addressing issues of evaluating systemic reform. In its four meetings during Year 1, the panel members each brought their perspectives to defining the project's work and shaping relevant issues for evaluation of systemic reform. This panel will continue to meet in Year 2, with meetings increased in frequency to monthly rather than every two months. The panel's role will shift from primarily advisory to more active engagement

to bring their members' expertise as mathematicians and scientists to bear on project tasks. One possible task for the panel is to design review procedures for judging the intellectual qualities being assessed by evaluation instruments.

Continuing Efforts

Alignment of Standards, Frameworks, and Assessment Systems. A paper, begun in Year 1 and to be completed in Year 2, is being written on procedures for determining the alignment of standards, frameworks, and assessment systems. Existing alignment procedures used by states will be described, and recommended approaches will be extracted.

Bibliography of References Related to Systemic Evaluations. An indexed and annotated bibliography of references related to systemic evaluations will continue to be developed and expanded. This resource will be available on the NISE Web page. Key words pertinent to evaluation, ratings of usefulness, and other means for an evaluator to locate relevant information will be identified to provide timely access to the growing knowledge base on systemic evaluation.

Special Emphasis Panel on Evaluation. The Special Emphasis Panel on Evaluation exists to provide technical assistance and recommendations on the full range of activities supported under the evaluation program of the EHR Directorate of the National Science Foundation. The panel was created at the request of EHR as an added activity to the NISE. Work has proceeded in a collaborative fashion, with Andrew Porter providing the lead for NISE and Daryl Chubin and Conrad Katzenmeyer providing the lead for EHR.

Staff

An active working group has been formed of people from many SMET areas. Norman Webb has served as the leader of the project. In Year 1 Daniel Heck served as the assistant researcher to the project. Donald Chambers is assuming this role and that of the coordinator of the project beginning in Year 2. The panel members and their fields are Christopher Anderson (astronomy), Vicki Bier (industrial engineering/applied mathematics), Steven Bauman (mathematics), Tom Carpenter (mathematics education), Donald Chambers (mathematics education/evaluation), Susan Millar (evaluation/anthropology), Senta Raizen (science education/evaluation), Tom Romberg (mathematics education/evaluation/assessment), Pat Rossman (science teacher), John Witte (political science/evaluation), and John Wright (chemistry).

Professional Development

Professional development is essential to effective educational reform. The EHR goal that every child in the United States has access to high-quality school education in science and mathematics cannot be realized without the availability of effective professional development for teachers. The intent of this project is to capture the learnings of current professional development efforts that will increase the knowledge base from both "craft wisdom" and disciplined inquiry and make that information accessible to practitioners and researchers alike.

The project has three goals. The first is developing a framework for the design of professional learning opportunities for K-12 inservice science and mathematics teachers in order to expand the range of alternatives available to professional developers beyond the traditional format of workshops and institutes. The framework is a decision-making process that incorporates a number of central components: a cyclical design process, robust professional knowledge bases, professional development strategies, context, and critical cross-cutting issues. It is a product of the analysis of Year 1 Fellows' current professional development projects.

The second goal of the project is to create a professional dialogue for elaborating and understanding the design framework and the issues raised in implementing, sustaining, and scaling up professional development learning opportunities.

The third goal of the project is to create products that provide guidance to designers, funders, consumers, and evaluators of professional development. The first of these is an NISE Brief on Principles of Effective Professional Development for Mathematics and Science Education, a synthesis of the professional development standards included in standards produced by various organizations including NCTM, the National Research Council (NRC), the National Staff Development Council (NSDC), and NCISE. The second is a book to describe and illustrate the design framework that is intended as a resource for the professional development community in science and mathematics. We recognize that, while the book will be a visible outcome, more important are the means by which professional developers become aware of the central components of the framework and use them in designing professional development experiences.

At the first NISE Annual Forum in March 1996, the project team outlined the framework of professional development and led case discussions of professional development projects. The Forum was helpful in refining the description of the framework and its implementation, gathering examples and illustrations to supplement those currently available, identifying people interested in being linked to a professional development network in the future, and informing the broader community of the work of the project.

Year 1 Accomplishments

Our accomplishments in Year 1 included (a) the development of a framework for designing professional learning opportunities (Goal 1 revised); (b) the establishment of a learning community on professional development in science and mathematics; one important contributor to this was the planning of, preparation for, and participation in the NISE Annual Forum as the featured project (Goal 2); and (c) the planning and writing of a book on effective professional development of mathematics and science education, with the design framework as the keystone (Goal 3).

The framework for the design of professional learning opportunities for K-12 inservice science and mathematics teachers is a decision-making process that incorporates a number of central components. These components are that the design occurs cyclically from planning through implementation stages, that it is informed by robust professional knowledge bases, that it draws on a variety of strategies available to professional developers, that it occurs within a specific context containing various factors that need to be considered, and that it addresses several critical issues that cut across all professional development.

The framework is based on an emerging national consensus on standards for professional development in mathematics and science education. A major part of the professional knowledge base informing professional development is an extensive body of literature that describes excellent mathematics and science teaching and its foundations in a coherent set of specific beliefs about students' knowledge of and ways of learning about science and mathematics, about the nature of the disciplines of science and mathematics, and about relevant teaching methods in science and mathematics. Several of the available professional development strategies are primarily focused on the mathematics and science of the curriculum as teachers learn to teach content units, develop and revise new units, or immerse themselves in the processes of inquiry of science and mathematics or in the world of scientists or mathematicians. One of the cross-cutting issues concerns the roles of scientists and mathematicians in professional development.

The strategy used to achieve the goal of professional dialogue is to establish and develop a learning community consisting of people with a variety of professional development interests, including professional developers, mathematics and science educators, scientists and mathematicians, and evaluators. The learning community's purposes are to understand the nature of effective professional development in mathematics and science through reflection on and study of professional development activities, to educate its members about effective professional development, to sustain its members as they design and put into practice effective professional development, and to be the primary dissemination mechanism for the work of the project. In relation to the learning community, people differ in the roles they play, the expertise they are

able to contribute, the amount of time they can spend, and the outcomes they expect to gain. The NISE and the project supports a small, active core of people, while others in the wider learning community have their own means of support.

Year 2 Activities

In Year 2 the team is studying (a) the ways in which the design framework and its central components are implemented in different contexts and (b) the organizations, structures, and methods that serve to facilitate their effective implementation and dissemination.

The project is studying how a small number of programs in a variety of different settings use the design framework and its central components to provide effective professional development. Programs being studied are committed to (a) using the design framework described in the book, and (b) documenting and analyzing their implementation efforts. We are paying special attention to the similarities and differences that arise between the disciplines of mathematics and science. The programs studied in Year 2 are different from, and chosen to complement, those studied in Year 1. Representatives from these programs will work with the team in using the central components of the book to understand the ongoing cyclical design (including implementation) of professional development experiences. There are large projects with significant external funding (comparable to the work of Year 1 Fellows) and small, underresourced programs in order for us to address questions such as, What does effective professional development look like from the perspective of these projects and programs? Does professional development have to rely on large-scale, externally funded projects in order to be effective? How can a professional development program reconcile its local needs with national concerns expressed, for example, in various standards documents? An overarching question is, Are there professional development activities that are so small that they aren't worth doing?

The project is facilitating the use of the design framework by science and mathematics professional developers by working closely with professional organizations (e.g., NCTM, NSTA, NSDC, Association for the Education of Teachers in Science (AETS) to design learning opportunities at their conferences such as extended workshops, and other interactive sessions. The purpose of these learning opportunities is to raise peoples' awareness of the design framework, the role of professional development communities in executing the framework, and the range of vehicles used in the implementation of effective professional development. The intended outcome, beyond the scope of this project, is that participating professional developers will use the framework in designing their own professional development programs for inservice elementary, middle, and high school mathematics and science teachers.

The project is fostering the network established in Year 1 as a resource for facilitating the implementation of effective professional development experiences. We are studying the role of the participants as a primary means of disseminating the central components of professional development, as manifested in the book and case studies.

The project is studying various means of communication among the network of the wider professional development community. This mechanism is important for disseminating the ideas and products of the Professional Development project. Since participants in the community are geographically dispersed, the means of regular communication are primarily electronic. Meetings are another means of communication: independent meetings, satellite meetings in conjunction with meetings of professional organizations, and sessions as part of the meetings of professional organizations.

Staff

The Professional Development Project personnel include as team members Susan Loucks-Horsley and Peter Hewson (co-Project leaders), Nancy Love, and Kathy Stiles; Year 1 Fellows Hubert Dyasi, Susan Friel, Judy Mumme, Cary Sneider, and Karen Worth; Year 1 Reflectors Josefina Arce, Joan Ferrini-Mundy, Deborah Schifter, Vernon Sells, Mark St. John, and Iris Weiss; and Year 2 Fellows Edward Silver, Margaret Smith, and Mary Kay Stein.

EHR recognizes the importance of high quality undergraduate programs in SMET: These programs have a substantial impact on EHR goals of providing general SMET literacy for all students, preparing students for careers in SMET fields and teaching, and in addressing equity issues. The first year of postsecondary education is recognized as a curriculum "pressure point" in education. Experiences in first-year courses greatly influence career trajectories and lifelong attitudes toward SMET-related fields. The objective of the College Level One (CL-1) team is to identify and study critical issues related to these courses.

Year 1 Accomplishments

The CL-1 team held a workshop in June, 1995, at UW-Madison to help organize its efforts. Several dozen individuals, representing a variety of stakeholder groups, attended the two-day meeting. A Workshop Report, "College Level One: Articulation, Equity, and Literacy Issues," that summarizes the conference was the team's first deliverable. The workshop led to interrelated projects within CL-1, whose specific activities are described below. Collectively, we believe that these projects will enable our multiple audiences—students, parents, instructors, administrators, the NSF, and the public—to sharpen their understanding of first-year college SMET courses and their impact on SMET education. We are addressing such issues as how these courses can be made more attractive to students, add value for those who take them, and enhance the likelihood of success across the wide spectrum of students who enroll in them. To ensure broad participation in and dissemination of our work, we have established contacts with many education- and SMET discipline-based professional organizations, as represented by our Workshop participants. We are also collaborating with the NISE Professional Development, Communicating with Mass Audiences, and Interacting with Professional Audiences teams.

Pathways Project

The intent of this project, led by Walter Secada, was to characterize pathways through introductory CL-1 SMET courses taken by individuals who have entered various SMET-related career areas, including, for example, leadership, business, and teaching. Toward this goal, we are conducting analyses of large-scale databases of individuals as a function of their initial careers to see whether linear course pathways or nonlinear constellations of courses are appropriate metaphors. As part of this effort, we are examining articulation issues in an attempt to determine the extent to which credits and knowledge transfer between courses and across institutions. We have initiated campus and national efforts to analyze transcript databases that will let us explore issues related to pathways through CL-1 SMET courses. The paths taken by recent graduating majors, spanning a range of disciplines, are being determined, and these paths will be used to help identify a manageable pool of students in introductory SMET courses for more detailed study. A preliminary study, based on UW-Madison student transcripts, examined the impact of introductory mathematics and chemistry courses and revealed that this methodology has considerable potential. On a national scale, we are working with Dr. Clifford Adelman of the U.S. Department of Education. Adelman has conducted an analysis of the engineering path using the High School and Beyond college transcript data set. Dr. Lia Brillhart, a CL-1 Fellow, is collecting information on a state-by-state basis from two-year institutions on articulation procedures and issues.

Effective Practices Project

The overall goal of this project, led by Ann Burgess, was to identify, characterize, and disseminate information about a group of effective, sustainable practices in introductory CL-1 SMET courses and curricula. In collecting information about these programs, we are looking for common themes, strategies, and philosophies that make the courses or curricula particularly effective. Because we are selecting a group of effective practices that represent the diversity of the CL-1 population, including institution type, SMET content area, and student populations served, we expect to find a diverse group of approaches to reform and measures used to define effectiveness. While we intend to remain

open to considering new ways to measure effectiveness, we are relying on traditional measures, such as improvement in students' conceptual understanding and problem-solving skills (particularly in complex, real-world situations). Other measures are students' attitudes toward math and science, the fraction and demographics of students who successfully complete the course or program, and the number of students who go on to take a second SMET course.

Through discussions with CL-1 team members and others, we have narrowed the focus of our study to effective, transportable practices that have been sustained. The questions that we are attempting to answer are: (1) Will we find common components in a diverse group of particularly effective first-year SMET programs? If so, what are they? and (2) What are the key factors that allow effective practices to become institutionalized? Reports from agencies that award grants for improving college SMET teaching and publications and conference proceedings describing projects to improve introductory SMET courses and programs have been collected.

We have identified programs with which to begin our study by interviewing people in each SMET field who are "in touch" with national efforts to improve first-year SMET programs. We have begun the process of contacting by phone this initial list of nominees. The reports and phone interviews will provide us with more information about the specifics of each practice and evidence for its effectiveness. We are also exploring key factors that led to the program's initiation and allowed it to be sustained. In addition, we ask each practitioner to recommend other programs we should investigate.

Equity Project

Our project on equity issues, led by Janice Downer, was driven by considerable evidence that various population groups are differentially impacted by SMET courses (National Science Foundation, 1994). In light of this evidence, individuals teaching and administering CL-1 SMET courses need greater awareness of equity issues and an understanding of strategies for change such that they can better facilitate effective interventions for equitable participation. To this end, the objectives of the CL-1 equity project are to (1) further illuminate how certain practices in CL-1 SMET education may inequitably impact women, individuals of color, and students from low socioeconomic status (SES) groups; (2) categorize the current reform efforts from an equity perspective; (3) identify the underlying organizational structures that are inherently impediments to equity; (4) identify cultural and structural characteristics that have enabled successful practices to achieve equity; and (5) develop tools that will help administrators, instructors, and other stakeholders from a variety of institutional settings make informed choices regarding reform programs targeting equity.

Year 1 activities focused on gaining a requisite understanding of equity in higher education as it is defined in terms of educational opportunities, treatment, and outcomes and how current practices and innovative reform efforts in SMET education may have a differential impact on women, individuals of color, and students from low SES groups. An extensive survey of the literature is underway that seeks to identify the reasons that large numbers of academically able students avoid or leave CL-1 SMET courses. The review also will clarify the importance of formal support structures, educational practices, and student and institutional attributes in promoting student perseverance and success in SMET coursework. We are adapting a framework developed by Harvey and Klein (1989) for measuring educational equity as it applies to CL-1 SMET courses. Their approach looks at inputs, processes, and outcomes, as they involve individual learners and groups of learners.

Year 2 Activities

Year 1 activities helped establish an internal structure and external presence for our activities. In Year 2, we are building on this foundation to enhance awareness among the diverse stakeholder groups of the key issues associated with CL-1 SMET courses. Many issues of interest to NSF's Division of Undergraduate Education (DUE), such as cross-disciplinary sharing of advances in college SMET education, teacher preparation, articulation, and equity are embedded in our Year 2 projects. A

document providing a longer-term perspective on the priorities and objectives of the CL-1 team has been prepared for DUE. A key resource for the CL-1 team has been a report from the NSF Subcommittee for the Review of Undergraduate SME&T Education.

Some reorganization of the CL-1 team has been made to help us focus our efforts, most notably the merging of the Equity project with the Pathways project. The Equity/Pathways project is now under the joint direction of Walter Secada and Aaron Brower.

Effective Practices Project

As baseline information for year two activities, CL-1 is conducting, in collaboration with the NSF, a literature survey of postsecondary SMET educational research. This project will occur in three phases. In Phase I, a searchable database of relevant articles is being constructed and a taxonomy developed for its use. The database comprises entries from the ERIC database, augmented by articles from other leading sources of postsecondary SMET education research. When completed, the database, which will be updated quarterly, will be accessible to a wide audience of stakeholders via the NISE Web site and possibly by CD-ROM. Phase II will occur in two stages. In the short term, a few topics of considerable interest, such as practices that enhance equity in CL-1 SMET courses, will be selected and critically reviewed. A longer term component of this phase will be to identify other topics, using the database as a guide, and to critically review them. Products from these efforts will be a series of articles, published through NISE and the archival literature, and also accessible via the Web site. Phase III will provide a "behind the scenes" look at some of the topics by constructing a databook in collaboration with the Equity/Pathways Project (see below).

During Year 2, the Effective Practices project will continue to characterize SMET reform efforts by focusing on themes and issues that transcend disciplinary boundaries, identified in part through the aforementioned postsecondary SMET education research literature review project. The products resulting from this effort will integrate current theoretical perspectives, as found in the education literature, with case studies of model SMET reform programs. The combination of these perspectives will promote discussions between scientists and educators as well as provide practical tools to guide reform-minded faculty and policymakers. Craig Bowen and Leonard Springer, Fellows associated with this project, will assist us in the collection and analysis of data on existing reforms. Sheila Tobias, another CL-1 Fellow, will prepare a report on the role of CL-1 SMET courses in teacher preparation.

Equity/Pathways Project

A databook that will be developed in conjunction with the literature review project can reach a variety of audiences and call the attention of stakeholder groups to the emergence of a powerful new assessment tool: campus databases containing transcript and survey information. These databases are now accessible at a number of institutions.

The databook will contain statistics from a variety of disciplines and from two- and four-year geographically dispersed institutions that illustrate how, for example, changes made in CL-1 SMET courses led to quantitative improvement, using such metrics as subsequent course performance, retention rates, and time-to-degree completion statistics. We believe that the document will help catalyze the interest of other individuals and institutions in making such data available for analysis. Moreover, we anticipate it will raise consciousness among stakeholder groups about critical CL-1 SMET issues that include career preparation (including teaching careers), assessment, SMET literacy, equity, and articulation, as well as describe approaches to address these issues where they are being implemented. Factors that need to be considered in interpreting such data will also be presented.

This effort is being followed by more extensive transcript analyses, including completion of data collection from two-year institutions with the assistance of Lia Brillhart and initial characterization of the national patterns involving transfer into and out of these institutions. We are continuing to work with Clifford Adelman of the U.S. Department of

Education to characterize paths to a variety of SMET-related careers from the national transcript databases. This research includes use of a new database called "Baccalaureate and Beyond," administered through the National Opinion Research Center at the University of Chicago; it is designed to follow students for a minimum of four years after graduation.

Evidence for differential impact in the context of specific courses will be sought through studies examining enrollment profiles and performance in CL-1 SMET courses for underrepresented groups. An additional objective of this activity is to develop mathematical tools that can be applied to the transcript data of a broad spectrum of postsecondary institutions and used to measure student retention through SMET curricula. In parallel with this quantitative analysis is a qualitative analysis of the interaction of institutions with their student population. We seek to understand how administrators, instructors, and students interact with the curriculum and with each other in shaping objectives, allocating resources, and evaluating program effectiveness of existing support/intervention programs within selected institutions.

Staff

College Level One Team members presently include Arthur Ellis (team leader), Clifford Adelman (U.S. Department of Education), Craig Bowen (Fellow), Lia Brillhart (Fellow), Aaron Brower, Ann Burgess, Sam Donovan, Janice Downer, Abbe Herzig, Peter Hewson, Jack Husted, Robert Mathieu, Senta Raizen, Walter Secada, Leonard Springer, and Sheila Tobias (Fellow).

Interacting with Professional Audiences

The overarching goal of the Interacting with Professional Audiences team is to ensure that the new knowledge generated by the Institute gets into the hands of all professionals who can make use of it. The team helps Institute researchers identify and connect with relevant audiences beyond the academic community and develop effective means of reaching them. As a result, a much broader range of professionals and their organizations will be knowledgeable enough to make use of Institute endeavors than is often the case for university-based research projects. The three primary goals of the Interacting with Professional Audiences team are (1) to share knowledge and information generated by NISE with key SMET stakeholders, (2) to promote interaction and dialogue among SMET stakeholders about NISE research directions and applications, and (3) to encourage policymakers and practitioners to put research knowledge about SMET education into action.

Year 1 Activities

The first NISE Annual Forum

The IPA team invested a majority of its Year 1 effort in making the first NISE Forum a premier event in the science, mathematics, and technology education communities. The Forum's purposes are to make relevant professional audiences aware of NISE work, but, just as importantly, to gain those audiences' perspectives on and participation in NISE work. The process of planning and conducting the Forum has established an active, collaborative process within the Institute and with NSF and potential dissemination partners for the Institute.

The first Forum, Professional Development for Science and Mathematics Education—Putting Knowledge into Action, was very effective. The agenda showcased the Professional Development team's project, but also enabled every NISE team to introduce its work and solicit input. Because several corporations suggested by the National Science Teachers Association—Delta Education, Duracell, Merck, Toyota—made donations, the Institute was able to avoid charging a conference fee. A wide range of professionals participated, approximately 70% of them from outside Washington, even though the federal government shutdowns permitted NISE to provide only two months notice for the event. The Technical Education Research Center (TERC) distributed major NISE Forum presentations in audio and text form via the Internet to a network of professional developers, including all Forum participants. The NISE Formative Evaluation team's interviews and questionnaire about the Forum indicated very high participant satisfaction with the event.

Over 1,600 influential individuals were invited to the Forum. This large number of people was contacted despite the space limitations of 200 participants in order to begin awareness of the Institute. The IPA team contacted executive staff and elected officers of over 150 organizations, not only those in science, mathematics, engineering, technology, and education, but also organizations and individuals with a more general interest in and influence on science and education policy. The database of Forum invitees will be used as a foundation for future Annual Forums: it already is being used for Institute mailings to announce study results, publications, etc.

Recruiting dissemination partners

The IPA team staff met with executive directors of senior staff of NSTA, NCTM, NRC, and NSDC, who agreed to have their organizations become Institute dissemination partners, beginning with cosponsorship of the first Annual Forum (except NRC). These organizations are considering copublication or secondary distribution of relevant reports produced by the NISE and inviting Institute projects to make highlighted presentations in their annual conferences. For example, the NSTA invited the NISE Professional Development team to conduct half-day versions of the NISE Forum's agenda during all NSTA regional conventions in Fall 1996 and to have a prominent program slot in the 1997 annual meeting.

Helping NISE teams and management to develop dissemination plans

The IPA team suggested activities to NISE teams and management that might be appropriate parts of their dissemination plans. Potential strategies include innovative activities such as making thoughtful use of the Institute's Web site, gaining coverage by professional newspapers such as *Education Daily* or the *Chronicle of Higher Education*, and working with partner organizations to develop articles in their periodicals that tailor Institute project results into findings for specific audiences. Teams are weighing the advantages of these less common strategies against the effectiveness of more typical dissemination activities used in academia such as presenting at conferences and including articles in refereed journals. As the plans of each team for specific products unfold, further progress can be made on NISE's overall five-year plan.

Year 2 Activities

Organizing the Second NISE Annual Forum

Organizing the second Annual Form will be the largest IPA team activity. The database will be revised and augmented to address the agenda focus for Year 2. Relevant organizations will be contacted to cosponsor the event such as the Council of Chief State School Officers (CCSSO), the Consortium for Policy Research in Education (CPRE), and the Education Commission of the States (ECS). The IPA team will have primary responsibility for ensuring that the Forum agenda addresses the needs of educators as identified by NSF and other key audiences. The IPA team will also manage all of the logistics of the Forum, including mailing invitations, making personal calls to targeted participants and organizations, arranging for a conference site, negotiating meeting logistics, preparing conference materials, and making travel arrangements for presenters and NISE staff.

Advising and helping NISE teams and management with dissemination activities

The focus in Year 2 shifted from helping the teams develop preliminary dissemination plans and matching them to the needs of various constituencies to helping them actually produce the products and outputs of their work in forms most useful to their various constituencies. The IPA team will provide technical assistance in three primary areas: (1) giving guidance to teams about the information needs of targeted audiences, e.g., teachers and local educators attempting reform; (2) recruiting new associations as partners and contacting publishers that reach the targeted audiences; and (3) helping the researchers to prepare publications and presentations for the target audiences.

For example, once a team identifies work that has potential for commercial publication as a book or monograph, the IPA team helps by developing a prospectus and talking with publishers whose holdings fit the product and whose marketing bases match desired audiences. To illustrate, the IPA team advised the Professional Development team in preparing a prospectus for its first book. One publisher already has expressed very strong interest. Since the plans for each team's specific products are still unfolding, the overall NISE Dissemination Plan prepared in Year 1 is being managed, reviewed, and revised throughout Year 2 as each team makes final determination of its products and outreach for its projects. The IPA team is meeting with each team leader quarterly to identify the dissemination strategies having the highest impact from the perspectives of the NISE, NSF, and NISE dissemination partners.

Securing commitments from NISE partners

The IPA team acts as a liaison between organizations and specific teams to share information and knowledge from the research that is of particular interest to the organizations and to help their constituencies understand and apply Institute work to the reform of science and mathematics education. The IPA team also works with the associations to get commitments from them to create spinoff publications, e.g., articles in journals and periodicals that highlight and tailor Institute results to the organizations' constituencies. The goal for Year 2 is to secure commitments from these partners for up to three cosponsored products.

In Year 2 we will expand the number of dissemination partners to include other science and mathematics organizations and associations and reach out to the policy community to involve them in the Institute's work. For example, we are meeting with the scientific societies such as the American Chemical Society (ACS) and the American Association for the Advancement of Science (AAAS), and education policy groups such as the CCSSO and the ECS. We also are maintaining communications and nurturing the working relationships we established with associations in Year 1.

Design Year 3 study of scaling-up issues

The IPA team plans to launch a study of the implementation issues that surround reform efforts as they "go to scale." The field does not know enough about what it takes to scale up and how to best achieve scale from development efforts. In Year 3, the IPA team will initiate a study of educational reform models and programs that have effectively reached a substantial level of effort. To inform this study, in Year 2 the IPA staff will convene a panel of dissemination experts, as well as program developers and funders.

Three planning documents are being prepared to inform the Year 3 study of Scale-up: (1) a list of programs that are believed to have achieved reasonable scale and some background information on how they have achieved this status, (2) a set of criteria for analyzing sites believed to have scaled up, and (3) a set of study questions that will be addressed in the Year 3 research.

Staff

The primary staff for the Interacting with Professional Audiences tasks are Senta Raizen and Ted Britton of the National Center for Improving Science Education in Washington, DC. Other NCISE staff assist in conducting specific Interacting with Professional Audiences tasks such as organizing and recruiting participants for the Annual Forum and meeting with association contacts to generate interest in the Institute's work.

Communicating with Mass Audiences

The team's mission has two related components:

- Developing a better understanding of how to use the World Wide Web to promote science literacy;
- Creating greater visibility for the NISE, to encourage participation in the Institute and engender support for SMET education initiatives through core news support.

Year 1 Accomplishments

SMET literacy on the World Wide Web, Phase One

Our team reached its first major milestone: developing and disseminating to the public a Web site that promotes SMET literacy by creating information packages pegged to mass media headlines. The Why Files (the name is a play on the hit television program "The X-Files") combines skillfully written text, compelling graphics, timely news photos, and strategic linkages to other Web sites to produce a powerful communication tool to mass audiences.

The Why Files (http://whyfiles.news.edu/) is uniquely positioned on the Web, because it builds on the public curiosity generated by breaking news stories. Unlike the preponderance of Web sites that either recycle information already published in paper or other form or serve as clearinghouses for Web sites, The Why Files, created strictly for the Web, regularly tantalizes the public with a more in-depth look at topics already on their minds, thanks to the mass media. A few early examples from The Files:

- When AIDS activist Jeff Getty made national headlines by receiving a bone marrow transplant from a baboon, we knew it was time to explore the issue of human-animal transplants.

- A highly publicized die-off of monarch butterflies in Mexico prompted us to create an information package that explored animal migration.

- The 1996 Presidential primaries inspired us to develop a package on the statistical underpinnings of political polling.

- California's decision to delay implementation of requirements for electric cars gave us the opportunity to discuss the future of electric cars, particularly issues of battery development and air emissions.

- The 1996 Olympics gave as a chance to highlight the role of science and technology in the games.

We employ standard Web feedback tools to help us evaluate The Why Files. We can track the number of site visits and the geographic origins of the visitors; the portions of the site that the visitors download; and the times of day and dates that the site is accessed. We have an e-mail feedback mechanism easily used by visitors and have established a Netforum for various lines of discussion.

To go beyond these basics and conduct a more thorough evaluation of the effectiveness of this communication product, we have developed a formal evaluation plan for The Why Files and are embarking on the first stages of that plan. The evaluation plan includes setting up test sites (computer terminals dedicated to displaying The Why Files) in schools, museums, and other remote locations and using a variety of interview and observational techniques to obtain visitors' impressions of the Web site and to learn what Web users attend to and why or why not.

Through this evaluation process, we expect to reach our ultimate goal of determining what constitutes effective Web-based promotion of SMET literacy and for whom. We expect to learn whether a communications product like The Why Files is most likely to be effective in the formal education process, or whether it has a more significant role as an informal science education vehicle.

Anecdotal responses to The Why Files confirmed our suspicion that Web users appreciate frequent site updating. Our staff is committed to producing a new lead feature package every two weeks, as well as regularly "refreshing" other elements of the site (such as Cool Science Images, a collection of striking SMET-related photos and graphics plus explanatory captions) to keep them interesting. Frequent updating supports our goals of tapping into themes that are recently in the news and of encouraging return visits to the Web site.

We are beginning to market The Why Files to mass audiences, in order to maximize the impact of our communications product. Currently, an estimated 100,000 people per month visit the site. Examples of that activity include:

1. Offering the Web listing to individuals and organizations that catalogue, review, and publicize Web sites. Thus far, we have targeted more than twenty directories, indices, and webcrawlers, sent out three USENET postings, and contacted ten national educational organizations. Many already have indicated they are listing us. Microsoft selected The Why Files as its Site of the Day, and the NCSA placed The Why Files on its listing of new noteworthy sites (both around February 24) and visits soared.

2. Approaching authors of other SMET- and education-related Web sites to establish hotlinks. The National Science Teachers Association just included The Why Files as a new, interesting site and placed the logo, hot-linked, in their site. The Cornell Theory Center Math and Science Gateway is another important link for us. New links are reported on a daily basis.

3. Developing press packets for traditional media outlets, including color prints of pages and Why Files business cards.

4. Networking with science (and nonscience) journalists/groups and displaying The Why Files at conferences. (The Why Files was one of two sites highlighted at the 1996 AAAS annual meeting session on Web communication.)

5. Pursuing contacts with informal science educators, programs, and institutions. Our first effort in this arena was to establish a relationship with the Milwaukee Public Museum as a pilot effort. We installed a computer terminal at the museum to showcase The Why Files and build it into their Clue Crew program for children, which challenges young visitors to find the answers to a series of questions in the exhibits. The museum is expanding its outreach efforts, particularly with respect to the Milwaukee minority community, and we will explore other museum collaborations to reach museum visitors of color.

NISE Visibility: Core News and Information Support

Our team has produced a number of written feature articles and media news tips highlighting the creation of the NISE. Most of this effort has had only in-state impact, although an in-depth feature article in the University of Wisconsin-Madison's alumni magazine was circulated nationally and prompted some intriguing responses.

The team created an NISE home page on the Web (http://whyfiles.news.wisc.edu) to enhance internal communication and increase direct public access to the Institute and assisted in the development of an NISE brochure. The NISE Web site displays the Institute's strategic plan and organization chart and features an NISE roster and selected bios. It offers the public information on how to participate in the NISE and features examples of media coverage. A Netforum was recently added to the site so that NISE participants can use cyberspace to communicate and solicit feedback.

In an effort to attract some early visibility to the NISE and demonstrate a novel informal way to promote science literacy, we were inspired by College Level One Team Leader Art Ellis to develop SMET-based brain teasers for university sporting events. In early Fall 1995, we launched a pilot project of SMET-based football-related questions, displayed on the Camp Randall Stadium scoreboard at University of Wisconsin-Madison home football games.

The pace of college football games allowed us to find appropriate moments to insert the questions, known as "Barry's Badger Brain Teasers" with the cooperation of UW Football Coach Barry Alvarez. After some time spent perfecting the technical delivery of the quiz during the game, the brain teasers developed a following with the crowd and became a popular feature of the football game experience. We publicized the project and earned both local and national attention, most notably in the December, 15, 1995, issue of *Science*.

Buoyed by the success of the football pilot, we brought the brain teasers indoors for the men's and women's basketball season, dubbing the product "Dick and Jane's Badger Brain Teasers" after Basketball Coaches Dick Bennett and Jane Albright-Dieterle. The new logo, created by our team's graphic artist, featured "Spot," a dog, to accompany "Dick and Jane." Technical difficulties (an extremely small scoreboard and antiquated computer support system) made this project more challenging to accomplish. The pace of the basketball games also made the visible introduction of the brain teasers more difficult. By the start of the Big Ten season, the brain teasers were largely in place.

Once we had a full complement of model brain teasers, we placed them in The Why Files web site, so that others could adapt them at will. Early data on visitors show that the "Sports" section is a popular place in The Why Files.

Year 2 Activities

Using the Web to Promote SMET Literacy

The World Wide Web is such a new technological tool that there is very little literature on the efficacy of its use for mass audience communication, and even less on using the technology to communicate science concepts. However, because of the burgeoning development and use of the electronic environment of the World Wide Web, it is essential to conduct systematic studies of how this new medium may be used to foster SMET literacy in diverse audiences, including the public at large. Moreover, the Web has great potential for study. Already, with existing software, one can collect a wealth of statistics from visitors who leave click-

able trails or road maps of their interests in the site.

By combining human and electronic resources, it is feasible to ascertain patterns of Web site use and to explore a series of related questions: What proportion of visitors skim by a site or genuinely engage themselves in the process of being informed? Can we categorize visitors based on their levels of involvement with the site's information, and how might such categorization lead to improvement in the design and content of a Web site? What types of information, presentation, or other characteristics draw visitors to particular parts of a Web site? And, of most basic concern to the NISE, is a Web site a communication channel that can effectively empower people to learn and use SMET-related information in their daily lives?

The Communicating with Mass Audiences team is well-positioned to conduct ground-breaking research on the efficacy of World Wide Web SMET communication. The Why Files is developing into a site with optimal characteristics for meaningful Web research. It features, and will continue to feature, many of the latest multimedia presentations and takes good advantage of this new communication medium; it is regularly updated, a facet that encourages repeat visits and offers visitors many choices; and it presents timely, news-inspired information that may appeal to a mass audience.

In Year 2, the team is developing a research effort by forging links with respected scholars in science communication and drawing on researchers who are developing special expertise in the area of learning and the new educational technologies. UW–Madison Journalism Professor Sharon Dunwoody, a national expert on science communication is leading this research project. The research program has two phases.

In Phase One, the research team is gathering descriptive data on Web communication patterns, using The Why Files audience members as prospective study subjects. (We are consulting experts on the use of human subjects before proceeding.) Research questions will include, Who visits this Web site and how often? How do they travel within the Web site? And what sorts of information/experiences interest or attract them within the site? We are seeking out scholars who are already looking at these types of issues, both to inform our work and to avoid potential duplication.

In Phase Two, using the initial information gathered, the team will delve more deeply into questions about the effectiveness of communication via the Web. In particular, we will explore whether and how visitors to The Why Files are empowered to understand SMET concepts as a result of their experiences with the site. Studies of lay people's attitudes about science repeatedly demonstrate high levels of interest but accompanying feelings of ignorance. That is, people feel helpless when confronted with scientific information; they feel that they cannot understand it. We hope to see whether use of well-designed scientific Web sites ameliorates this sense of helplessness.

As a result of our inquiry, we hope to be able to suggest specific strategies for improving Web communication. These strategies will then be tested by our Why Files developers and studied again, using standard research and development processes.

Core News and Information Support

Our primary goal is to increase awareness of the NISE by:

- publicizing newsworthy deliverables;
- positioning NISE personnel as SMET education experts;
- aggressively marketing The Why Files to increase its reach

Staff

Susan Trebach is the director of the UW–Madison's Office of News and Public Affairs (ONPA) and the team leader. Terry Devitt, science editor for ONPA, is the NISE/Communicating with Mass Audiences project coordinator. Amy Toburen, associate director of ONPA, works on general NISE media relations and is a contributor to The Why Files project. David Tenenbaum, a veteran science communicator, is our chief science writer. Yael Gen, formerly of the Smithsonian Institution, is our graphic designer.

Cognitive Studies of Interdisciplinary Communication

A major strategy of the NISE is to create interdisciplinary teams to work on the Institute's mission of improving SMET education. Within the Institute, experts from a variety of disciplines form working teams of various duration that study significant issues and propose and carry out projects related to NISE goals. Such interdisciplinary teams are increasingly common in industry, government, and society in general and are often utilized by the National Science Foundation to guide and facilitate its decision-making processes. Many of NSF/EHR's current goals and strategies involve promoting interdisciplinary inquiry into the problems of education. It is therefore not surprising that a substantial body of literature and much "wisdom of practice" on interdisciplinarity have emerged in recent years (e.g., Chubin, Porter, & Rossini, 1986; O'Donnell, DuRussel, & Derry, 1996). Nevertheless, we still possess limited scientific understanding of how social and cognitive processes interact to drive intellectual growth and construction of intellectual products in natural interdisciplinary groups. Such knowledge might be applied to the design of better procedures and technologies for improving interdisciplinary inquiry.

The goal of the Cognitive Studies of Interdisciplinary Communication team is to understand interdisciplinary collaboration and improve such collaboration within the NISE. We are reviewing research and conducting observational studies of NISE teams that will help us describe, understand, and ultimately design and implement new ways to facilitate the communicative processes that influence productivity and quality of work in interdisciplinary teams. We hypothesize that good collaborative teams will evolve toward a state of "collective intelligence," which entails functioning more like a coherent, intelligent organism than like a collection of disassociated, independent thinkers. Like other researchers (e.g., Smith, 1994), we hypothesize that collective intelligence is a type of group behavior that might be promoted and enhanced through design and use of technologies that facilitate idea processing during and between team meetings.

A unique and important feature of genuine interdisciplinary collaboration is that it depends heavily on face-to-face conversation. Such conversations are often lively social events, varying substantially in terms of length, intellectual content, and the structural and conceptual complexity of arguments that are aired. Many of the most substantial intellectual accomplishments within collaborative groups—in terms of the knowledge that is constructed and the questions that are raised—are found in the conversation that takes place during face-to-face meetings. Unfortunately, most conversations are ephemeral entities—elegant knowledge structures that exist in the air and may largely disappear when conferences or meetings end.

Capturing the knowledge that is constructed during intellectual conversation is especially important to institutes and conferences of the "think-tank" variety, since many experts who contribute substantially to such conversations do not instrumentally participate in the creation of documents or other artifacts that represent the synthesized institutional memory of conversational content. Creation of such artifacts is often based on methods of note-taking that are inadequate with respect to the task of capturing the intellectual content of knowledge-building conversations. The written artifacts later produced from those notes can represent highly processed ideas that are substantially edited, selectively abbreviated, and cognitively biased by the individual that produces them. The resulting documents may be incomplete and distorted as institutional memories of meetings and conferences, and, as intellectual products, they could possibly be inferior to conversations they purport to document.

For example, in our study of one NISE team, we observed that a written summary of what four groups accomplished at a working conference was carefully designed and constructed by the team leadership to serve as an intermediate foundation for further knowledge building by that team. This was a particularly interesting case of how meetings can be thoughtfully engineered by team leadership

(using technology and discussion formats) to produce intermediate working documents that are meant to further the collaborative work of a team. We also observed that document preparation was labor intensive, that the document could not possibly be turned around with great speed, and that it now exists in a standard written form, which cannot be conveniently built on and edited during further group conversation. In fact, the document has so far had very limited impact on the work of the team. We hypothesize, therefore, that a technology might exist or be designed that could greatly facilitate team leaders' efforts to create and build on supporting intermediate documents that capture intellectual content of interdisciplinary conversation.

The newly developing field called Computer Support for Collaborative Work (CSCW) is currently attempting to address some of these issues (e.g., Smith, 1994). This specialty includes the development of theories about the nature of group intelligence and the design of technologies that help enhance, capture, and preserve such intelligence for further use. The work of the Cognitive Studies of Interdisciplinary Communication group is related to this exciting, growing field.

Year 1 Accomplishments

The primary activity of the CSIC team in its first year was to initiate intensive studies of three teams within the NISE—the Strategies for Evaluating Systemic Reform (SESR) team, the Team Leaders Team (TLT) and a working research subcommittee of the College Level 1 (CL-1) team. We (1) analyzed detailed conversational processes and (2) studied the genesis and maturation of team knowledge and functioning over a lengthy period of time. Our analyses have primarily focused on collaborative conversations that can be observed and recorded, tracing their impact on the papers, reports, and other products produced by the teams.

Data analysis began in earnest as we attempted to further develop and clarify the theoretical framework and language we will use for further data collection and analysis and to describe our observations. Our approach has been largely qualitative in the sense that we are descriptively analyzing team processes in detail to contribute to theory about effective collaborative work and to further knowledge about how interdisciplinary perspectives influence team functioning. We employed some quantitative methods in data handling and coding to help build a better case for the consistency and validity of our observations and interpretations.

We created three products in Year 1: a literature review, a theoretical analysis of the usefulness of sociocultural theory for our work, and an in-depth analysis of cognitive processes during early development of one NISE team. The literature review synthesized research from social psychology, cognitive psychology, small group research, and other fields to highlight the major issues influencing cognitive and social processes in interdisciplinary teams (O'Donnell, DuRussel, & Derry, 1996). This paper is currently available through the NISE. The theoretical paper (DuRussel & Derry, 1996) used a sociocultural perspective—a theoretical viewpoint that implies certain methods and approaches currently being debated in the social sciences—as a basis for analyzing data from the first few meetings of one team. It showed how processes of apprenticeship and use of "common voices" within the team contributed to the team's initial development, and it also discussed some of the benefits and limitations of using a sociocultural approach. A short version of this paper was published in the proceedings of the 1996 Cognitive Science Society Annual Meeting and was presented as a poster at that meeting. The third paper (Derry, DuRussel, & O'Donnell, in press) explored meetings of the SESR team in more depth. It examined how the conversation revealed evidence of distributed cognition, the co-development of ideas among several members of a group. It also discussed elements of SESR team dynamics and process that prior research indicates could be relevant to team functioning and effectiveness. This paper was delivered at the 1996 annual meeting of the American Educational Research Association and will appear in a special issue of *Educational Psychology Review*. The topic of the special issue is Distributed Cognition.

Year 2 Activities

The following projects will be completed in year 2:

1. Analyses of the growth and productivity of the Team Leaders Team, the CL-1 working subcommittee, and the SESR team.

2. A review and analysis of how technological and nontechnological tools for idea processing (such as a computer-based white-board system and an accompanying conference format for using that tool) are now being used to enhance interdisciplinary teamwork in academic and nonacademic settings. We will consider whether an appropriate tool set (computer system and recommended procedures for using it) could be useful to the NISE and how it should be designed.

3. An *NISE Brief* discussing what the Cognitive Studies of Interdisciplinary Communication group has learned regarding interdisciplinary collaboration and why it is important.

4. The mini conference described below:

   In November 1996, the Cognitive Studies of Interdisciplinary Communication team is hosting a small conference on interdisciplinary teamwork focusing on understanding collaborative processes and how to manage team-based meetings, organizations, and conferences. The conference will include faculty participants from the NISE as well as invited participants who have special expertise or experience pertaining to interdisciplinary collaboration and problem solving and who are conducting research on the topic of interdisciplinarity. The questions that will guide discussions and activities during the conference are:

   What is the current theoretical base for understanding interdisciplinary collaboration?

   What is already known about interdisciplinary collaboration that can be applied to NISE work and beyond?

   What are the best known methods for studying interdisciplinary collaboration?

   How can current and developing research findings contribute to the enhanced performance of interdisciplinary teams?

   What technological enhancements and tools might be used to facilitate teamwork within the NISE?

   How might answers to the above questions help other research and educational reform partnership teams?

   The types of activities to be included in this conference are as follows:

   1. Keynote addresses by Dr. Gavriel Salomon, an expert on distributed cognition, and Dr. Julie Klein, an expert on interdisciplinarity.
   2. Presentations by other invited researchers and authorities on interdisciplinarity.
   3. Small group discussion of key issues in working with interdisciplinary teams.
   4. A demonstration of technological tools to support collaboration.
   5. A panel discussion on methodologies for the study of interdisciplinary teams.

Staff

Sharon Derry leads the team. Lori DuRussel, a graduate student in educational psychology, works as a research assistant. Dr. Angela O'Donnell, an associate professor of educational psychology from Rutgers University and an NISE Fellow, spent six weeks during Summer 1995 in residence at the Institute. She returned for a brief second visit during February 1996. Jan O'Neill is a consultant. A part-time research position is currently being advertised.

NISE Formative Evaluation

The Formative Evaluation team's primary role is to provide internal "formative feedback" information to improve the Institute's functioning as an agile and productive organization capable of achieving its stated and emerging goals. Secondary roles played by the Formative Evaluation team are to produce an evolving history of the organization; provide, gather, and manage information on organizational activity; and engage in collaborative work with various NISE teams.

Year 1 Accomplishments

Formative Feedback Reports

Context, Rationale, and Goals. Organizational research shows that participation in formative evaluation can significantly enhance the effectiveness with which an organization performs. The NISE has chosen to incorporate formative evaluation processes into its culture from the very beginning, with the intent of becoming a "learning organization" (Senge, 1990). To ensure that these processes are developed and maintained at a professional level, the Institute engaged Dr. Susan Millar, an anthropologist trained in evaluation research. Dr. Millar and her Formative Evaluation team depend primarily on structured, open-ended interviews with all types of individuals who hold a stake in the organization. The team also collects observational data on most major NISE events and a sample of team meetings and collects a sample of the written and electronic documents used to conduct the daily organizational and research life of the Institute. The Formative Evaluation team analyzes these multiple sources of information and provides feedback in the form of occasional reports for the Team Leaders Team and the Management Team (see below) and more frequent informal meetings with the co-directors and individual team leaders. In all its interactions with Institute participants—during interviews, observations, and "formative feedback" sessions—the Formative Evaluation team maintains an external ("outsider") yet proactive stance. It seeks to help participants become "reflective practitioners" (Schon, 1983) in the art of creating a uniquely multidisciplinary and cross-system organization designed to improve SMET education nationally.

Confidentiality is critical to the Formative Evaluation team's success in developing accurate, insightful, and consequential analyses of the NISE's organizational process. The team assures all persons interviewed and observed that the Formative Feedback Reports will respect confidentiality and are for use internal to the NISE. (By contrast, the other deliverables produced by this team are intended for a wide audience.)

Year 1 reports included the following:

- ***Formative Feedback Report #1.1: Baseline Report on the Team Leaders Team and Management Team (October 1995).*** The Team Leaders Team and Management Team used this report to help make decisions designed to improve the Institute's organizational structure and process and to define its emerging sense of organizational identity.

- ***Formative Feedback Report # 1.2: The First NISE Annual Forum (April 1996).*** The Formative Evaluation team provided two types of evaluation of the First Invitational NISE Forum. First, an informal formative feedback report was produced for the two teams that developed the Forum—the Interacting with Professional Audiences and Professional Development teams. This report evaluated the effectiveness of the early Forum materials and agenda, as assessed by members of "intermediary" organizations (see below). Second, Formative Feedback Report #1.2 was provided to the Leadership Team in April 1996. This report was based on two evaluation surveys completed by Forum participants and on structured observations and informal interviews conducted during the Forum.

- ***Report #1.3: Baseline Report on NISE "Intermediaries" (April 1996).*** A third feedback report was produced to help the NISE leadership teams understand the expectations and needs of organizations positioned to utilize NISE products/processes on behalf of students and teachers in K-16 institutions. This report was intended to help the NISE leadership optimize the NISE's ability to pursue projects that are actively valued

by these "intermediary" organizations and to pursue these projects in ways that enable the most effective types of interactions between the NISE and these intermediary organizations.

- ***Formative Feedback Report #1.4: Report on Non-Team Leaders Team/Management Team Participants (April 1996).*** A formative feedback report focusing on the NISE goals and experiences of Institute participants who are not members of the Team Leaders Team or Management Team was produced for the Team Leaders Team and Management Team in April 1996. This feedback report was intended to help the NISE leadership teams understand the organization from the standpoint of its diverse participants and thus enable them to make optimal decisions.

Year 2 Activities

Four formative feedback reports are planned for Year 2. The first of these reports will draw on interviews with the members of the Team Leaders Team and Management Team conducted in July and August 1996 and, more generally, on all the Formative Evaluation team's Year 1 data. This report is intended to help the Institute leadership optimize its strategies for implementing its Year 2 plans. A second report will assess the effectiveness of the Second NISE Annual Forum. The third Year 2 feedback report will be based on interviews with a sample of NISE intermediaries. At this time, it is expected that this study will be designed to help assess how typical members of the intended audiences of specific NISE teams are responding to the products produced by these teams. A final Year 2 feedback report will be based on interviews with all non-TLT and MT members of the NISE, observations of team meetings and workshops, and email and other intra- and cross-team correspondence. It will be made available to the leadership teams in early May 1997 in order to support planning for Year 3.

Story of the NISE

To achieve and maintain a national scope, the NISE requires a research staff that balances a core group of long-term participants with a cadre of more short-term Fellows and UW–Madison/NCISE participants. The "story" document will benefit the core participants by providing both a record and a shared understanding of the events that have shaped their organization. It will benefit the short-term participants by rapidly bringing them up-to-date on events and issues that the core participants either take for granted or do not remember. It is expected that this document will help foster a sense of "NISE identity" in both core and short-term participants. Finally, it may be of value to NSF staff and others who would benefit from an understanding of the organizational history and dynamics of the NISE.

Request for Information (RFI)

Every organization must maintain accurate and up-to-date information about its participants and their activities and deliverables. While the task of collecting and managing this information is tedious, both the organization and its funders require this information to assess organizational productivity. The Formative Evaluation team has designed a Request for Information (RFI) system that not only obtains and manages this information in an accurate and timely manner, but does so in a way that makes minimal demands on the NISE participants' time. The reports produced from the RFI information submissions will assist NISE team leaders, co-directors, and NSF program officers working with the NISE in their efforts to evaluate and disseminate the processes fostered and the products developed by the NISE.

Staff

The members of this team include Dr. Susan Millar, team leader and Director of UW–Madison's LEAD Center; Dr. Dianne Bowcock, a former school teacher with years of evaluation experience; and Sara A. Pfotteicher, who has expertise in evaluation and the history of science.

Summary

In the first year of the NISE, we have:

- initiated eight productive lines of research;
- recruited a diverse group of Fellows to collaborate with us in pursuit of our mission;
- made great strides in creating high quality interdisciplinary teams of researchers who work together effectively;
- established increasingly productive collaborative relationships with NSF/EHR's programs;
- implemented and modified, where appropriate, our proposed management structure, including the creation of a highly visible National Advisory Board that will meet in Fall 1996; and
- initiated collaborative work with a wide variety of professional organizations in SMET education.

Our emphasis on dissemination is paying off with, for example, a fully subscribed first-year NISE Annual Forum and The Why Files (explaining the science behind the news) on the Web being accessed by literally thousands daily.

Our continuing work is grounded in the following ways. First, we are pursuing work that reflects priorities for the EHR Directorate and is consistent with the mission of the NISE. Recognizing EHR's commitment to systemic reform, we are pursuing a number of efforts that collectively will shed light on progress in mathematics and science systemic reform and yield insights into how the reform efforts and their effects on classroom practice and student achievement can be strengthened. Increasingly, EHR is confronted with the challenges of satisfying the evaluation data needs of external audiences and EHR's formative efforts in program improvement. These needs are addressed in our Strategies for Evaluating Systemic Reform work and in convening and providing staff support for an EHR Special Emphasis Panel on Evaluation. EHR's major commitment to strengthening professional development in mathematics and science education is reflected in our work to further develop and test a framework for designing professional learning opportunities. EHR's commitment to reform in undergraduate education is addressed through our College Level One work that identifies and describes effective sustainable practices in introductory SMET courses and that seeks to clarify students' pathways through the SMET curriculum, especially in regard to equity and subsequent careers. To address EHR's concern for the gap between research and development knowledge, on the one hand, and education practice, on the other, we are pursuing work to close this gap, through both interacting with professional audiences and communicating directly with mass audiences. To inform and strengthen our own commitment to conducting this work through interdisciplinary teams, we conduct cognitive studies of interdisciplinary communication. Finally, we seek continuous improvements in our own efforts through our commitment to formative evaluation of all NISE projects and products.

The EHR's establishment of the NISE has created an enormous excitement across the SMET community. We have received hundreds of statements of interest, requests for information, and visitors to the Institute. Our mission is ambitious, but our commitment is great. At the end of five years, we expect to have launched a whole new approach for the continuous improvement of SMET education. The goal of high levels of SMET literacy for all segments of our population will have become better understood and more broadly accepted. New communities of scholarship and practice will have been established, where scientists, education researchers, and education practitioners work collaboratively to attack the enduring problems of SMET education, problems that have resisted solutions from more narrow approaches.

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